

PACIFIC SEABIRDS



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Dedicated to the Study and Conservation of Pacific Seabirds and Their Environment

The Pacific Seabird Group (PSG) was formed in 1972 out of a need for better communication among Pacific seabird researchers. The Group coordinates and stimulates the field activities of members involved in research and informs its members and the general public of conservation issues relating to Pacific Ocean seabirds and the marine environment. Group meetings are held annually and the PSG publication, *Pacific Seabirds* (formerly the *PSG Bulletin*), is issued biannually. Current activities include involvement in seabird sanctuaries, seabird restoration after oil spills, seabird/fisheries interactions, and endangered species. Policy statements are issued on conservation issues of critical importance. Although PSG's primary area of interest is the west coast of North America and adjacent areas of the Pacific Ocean, it is hoped that seabird enthusiasts in other parts of the world will join and participate in PSG. PSG is a member of the U.S. Section of the International Council for Bird Preservation and the International Union for Conservation of Nature (IUCN). Annual dues for membership are \$20 (individual and family); \$13 (student, undergraduate and graduate); and \$600 (Life Membership, payable in five \$120 installments). Dues are payable to the Treasurer (see Membership page for details and application). PSG is a member of the American Bird Conservancy.

Pacific Seabirds

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FORUM

PETREL PROBLEMS & PUZZLES (Plenary Presentation)

By John Warham

OLFACTION

A long-standing problem for tubenarists is the role of olfaction in burrow location. That many of these birds, particularly those in the *Procellariidae* and *Hydrobatidae*, use odours from their potential prey to find food at sea is strongly suggested thanks to the pioneering work by Tom Grubb, Bernice Wenzel and her students, and others. They found that a range of tubenoses was attracted to olfactory baits floated out at sea by day and by night. Recently Gabrielle Nevitt and associates (1995) have extended such work to show that dimethyl sulphide liberated by plankton is one of the chemicals involved, although the results don't entirely jive with some of the earlier work. For example, Cape Petrels evidently weren't impressed by her smelly lures whereas they were regular customers to the baits of the earlier workers.

Olfaction is a difficult sense to investigate. On land it's necessary to eliminate vision, hearing and proprioception. The birds themselves smell, their burrows smell, and in fog I've been guided towards a petrel island by following my nose. Direct observation shows that on many nights there is enough light for vision to be the major sense in finding their own from a maze of similar burrows. But some species and colonies are in caves or heavy forests where on dark nights there is no light anyway. So, unless the breeders don't visit their mates or chicks on such nights, and there is no evidence for such avoidance, then they are left with just olfaction plus proprioception as aids.

The experimental evidence is contradictory. James set out to test the hypothesis that the birds used their noses to work up an odour trail during their final approach in the general area of their nest. He put strong odour wicks into burrows of Manx Shearwaters masking (to the human nose) the natural ones of the birds. The owners were in no way diverted, returning to H 38 666 666 1H their own burrows as if nothing had happened. Likewise well-established and smelly nest boxes shifted a few feet were ignored; the birds at-

tempted to go to the sites where their original nests in the boxes had been. However, vision and proprioception were not excluded in these tests and with their impressive olfactory equipment why should the birds not be able to separate odours significant to their lives from the medley of others in the air? Is a sniffer dog unable to detect an illegal drug in a suitcase reeking of Chanel No.5?

Recently Benevenuti et al. (1993) worked with Cory's Shearwaters incubating dummy eggs. Using zinc sulphate they temporarily impaired the working of the nasal olfactory mucosa and found that such birds had significantly reduced homing ability when released away from the island compared with mock-treated controls. And another worker, Minguez (1997), using British Storm Petrels nesting in a cave, studied the reactions of the small chicks in getting back to their nests when displaced from them. Some of these experiments, perhaps all, were done in the dark. It was found that the chicks were able to navigate the few feet back to their nests but had much more difficulty when their nostrils were plugged. In addition, using an ingenious flexible Y-maze device to eliminate both proprioception and vision, it was found that older chicks could locate their own nest crevice from those of neighbours - seemingly olfaction alone could have been used.

My gut feeling is that the birds don't have their big olfactory bulbs and complex turbinal system just for finding food, that most rely on vision and memory and the feel of their surroundings to find their nests but use their sense of smell when it's needed. Perhaps we should try using a sniffer dog to see if it can pick out particular burrows or birds - the burrow smell will be the complex product from the 2 adults + the chick and its feces once the egg has hatched.

There are lots of problems here:

1. Where does the body odour come from? From sebaceous, anal, preen gland or other secretions? What chemicals are involved?

2. Does b.o. provide olfactory 'fingerprints' of individuals, sex, change with the breeding cycle and state, i.e. is it pheromonic?

3. What species smell and what don't and why do the giant petrels, H 38 666 666 1H *Macronectes*, commonly called 'stinkers', smell so strongly when they're diurnally active on land?

RESPONSES TO MAN-MADE SOUNDS

In 1615 the colonists of Virginia were starving and a shipload of the old and weak calling in at Bermuda en route for England were revived by eating the abundant seabirds, particularly the Cahows - the first of the 'Birds of Providence'. Years later, in 1790, the convicts and their guards on Norfolk Island were in a similar pickle when their food ship failed to appear and once again they survived on a petrel - *Pterodroma solandri* - the Providence Petrel of our area. They ate and ate and ate them all away. Both at Norfolk and Bermuda the birds were called down from the sky to their deaths and at Lord Howe Island where the species still survives in good numbers, it has long been known that these birds can be lured down by hand clapping and other sounds.

We were able to see how effective this was when at Lord Howe around the start of egg laying we called the birds down from the sky ourselves. The effect of "war-whooping" was dramatic: birds replied with excited "wik-wik" calls, those lower down dropped their legs and circled round, landed and tottered over the boulder beach towards us, eventually climbing onto it if we kept calling. We were evidently a sort of super-optimal stimulus. The basis of this response seemed to be that the rhythm of our calls matched that of theirs. Rhythmic hand-clapping seemed much less effective.

Rhythm seems to be the key also of some responses of petrels to other man-made sounds. *Hydrobates* storm petrels breeding near a lighthouse off the Norwegian coast flutter round the engine exhaust pipe. The pulsations of the engine seem to

match the pulses of the "chatter" call of these birds as revealed by comparisons of the sona-grams. And, back in 1960 I had found Grey Petrels *Procellaria cinerea* attracted to the exhaust pipe of our station engine at Macquarie Island, an attraction that I couldn't then explain, but which again, was almost certainly a response to the engine's pulsations.

Since I drew attention to the effectiveness of "war-whoops" in H 38 666 666 1H triggering responses from gadfly petrels about 12 different species have been found to behave similarly, sometimes replying from their nests as well as from the air. Some small colonies of *P. macroptera* have been located in this way. Other possible uses of this kind of lure would be when wanting to band or sample birds without removing them from their nests. However, these sounds seem to work mainly early in the season and may be attracting mostly nonbreeders. Another possible use would be to play back "war whoops" as attractants when trying to establish or re-establish prospecting birds to breed at new sites - they may be more effective than playbacks of the calls of the birds themselves. It would be good to find a similar 'Achilles Heel' for attracting *Puffinus* and other shearwaters.

DNA STUDIES

One of the surprises arising from DNA analyses was the suggestion that the *Procellariiformes* were not to be as ancient a group as many of us had thought. Although no fossil 'prototubinare' has been identified so far (the oldest possible petrel-like animal seems to be *Tytthostonyx* based on a humerus from the Cretaceous of New Jersey), I thought I could detect a range of reptilian characters not seen in other bird taxa. These include their olfactory powers as a state retained from the reptilian ancestor not re-developed after being largely lost as in most birds, their low body temperatures, the ability of the eggs to survive chilling for many days without dying and of chicks to become torpid when starved yet still survive. I suspect that both have the ability, rare in vertebrates, to digest wax esters. At least skinks will lap up spilled stomach oil avidly and I doubt that they do this just to lubricate their guts. Also, way ago a Swede, one Einar Lonnberg, studied the formation of the head shields of reptiles and birds and he reckoned that these could be homologised. The complex compound rhamphotheca of the tubenoses seem to be the best fit of all the taxa he

examined. However, who nowadays looks at anatomical papers published way back in 1904, even if published in English?

As far as the detailed work on the tubenoses goes, such as the phylogenies drawn up by Gary Nunn most of the DNA trees jive reasonably well with current systematics. The latest work by Nunn & Stanley (1998), based on mt-cytochrome b sequences, places the storm petrels at the base of the H 38 666 666 1H radiation, a position tending to support my suggestion of years ago that the tubenoses provide an example of phylogenetic size increase, as set out by Stanley back in 1973.

DNA work tends to result in proposals for splitting existing species taxa and raising subspecies and even populations to full specific status. Among the petrels this is exemplified by the albatrosses. Here Robertson & Nunn (1998) raise all the former subspecies of the Wandering Albatross to full species status viz *Diomedea gibsoni*, *D. antipodensis*, *D. amsterdamensis*, *D. chionoptera*, restricting *D. exulans* to the Tristan/Gough birds usually called dabbeneas. These workers do the same for the 4 forms of the Shy Albatross formerly known as *D. cauta*. They also bring back the genera *Phoebastria* and *Thalassarche* for the North Pacific species and the southern mollymawks respectively, a change that I foresaw in my 1990 book but hesitated to make at that time.

All these former subspecies are identifiable in the hand but, partly owing to their complex plumage changes with age (Wandering Albatrosses can take at least 20 years before their plumage stops changing at the moult), many are identifiable only with difficulty at sea from the deck of a pitching boat. Thus, while you can recognize a Wanderer in reasonable conditions all you can record is 'Wanderer sp.' using this new taxonomy. This is because the other *Diomedea*, *epomophora*, is distinguishable at sea, so recording a Wandering Albatross of undetermined species as *Diomedea sp.* would be inaccurate. The suggested taxonomy also gives the two subsp. of *D. epomophora* full specific status despite the fact that birds of the typical form have infiltrated the famous New Zealand Taiaroa Heads colony of the northern form where they have bred and so have their hybrid offspring. One consequence is that the mean laying date at that colony is changing.

Now this kind of classification may well be the way to go, however, a word of

caution. Because we have so many competent but amateur ornithologists, changing names is not something to be done without a detailed discussion among the competent experts. It would be quite different if we were discussing the phylogeny of animals like *tardigrades* where there are but a handful of workers worldwide. A previous example of a premature name change was that in which the family name of the storm petrels H 38 666 666 1H *Hydrobatidae* was changed to *Oceanitidae*, a change which was followed quickly in a number of field guides. In due course, after proper discussion, the International Commission on Zoological Nomenclature ruled that the correct name for the taxon was *Hydrobatidae*.... One possible way in which to overcome this excessive splitting as proposed by the DNA-ists is perhaps to use the concept of super- and allo-species, but, not being a taxonomist, this is just an aside!

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ARTICLES

POTENTIAL NESTING DENSITY OF MARBLED MURRELETS IN VALLEY-BOTTOM OLD-GROWTH FOREST IN CLAYOQUOT SOUND, BRITISH COLUMBIA

By Michael S. Rodway and Heidi M. Regehr

Abstract: Priorities for protection of nesting habitat for threatened populations of Marbled Murrelets (*Brachyramphus marmoratus*) are being established in some areas based on relative, below-canopy activity levels measured during repeated, intensive morning surveys. Activity levels have never been calibrated to a measure of nesting density, and estimates of relative habitat use are speculative. Our objectives were to: 1) determine the density of Marbled Murrelet nests in undisturbed, valley-bottom, old-growth forest habitat with high activity levels; 2) characterize the Sitka Spruce (*Picea sitchensis*) - salmonberry (*Rubus spectabilis*) flood plain habitat we sampled in terms of forest structure thought to be important to nesting Marbled Murrelets; and 3) measure observer bias in identifying potential nest trees and estimating numbers of potential nesting platforms from the ground. No recently occupied or old nests were found in 70 randomly selected trees containing potential nesting platforms that were climbed in a 64 ha study plot in the Ursus valley, Clayoquot Sound, British Columbia. Although actual nesting density remained unknown, results provided the first data on potential nest density and indicated a low density in an area considered excellent nesting habitat. Large, dominant conifers, Western Hemlock (*Tsuga heterophylla*) and Sitka Spruce, provided most potential nesting platforms available to Marbled Murrelets. Numbers of potential platforms estimated from the ground were lower on average than actual counts of platforms by the tree climber, especially for Sitka Spruce which had the highest numbers of potential platforms per tree. Further studies, in which a greater proportion of potential nest trees in a variety of habitats are climbed, are needed to determine actual nesting densities and estimate areas of old-growth forest required to protect established populations.

INTRODUCTION

Conservation of threatened populations of Marbled Murrelets (*Brachyramphus marmoratus*) (Rodway 1990, U.S. Fish and Wildlife Service 1992) requires protection of adequate tracts of old-growth forest nesting habitat (Ralph et al. 1995). Quantifying and prioritizing habitat requirements are handicapped by a lack of information on nesting densities and other demographic characteristics. At present, habitat priorities are being established based on relative, below-canopy activity levels (Burger 1995, Grenier and Nelson 1995, Hamer 1995, Kuletz et al. 1995, Miller and Ralph 1995) measured during repeated, intensive morning surveys (Ralph et al. 1994). Activity levels are highly variable at daily, seasonal, and interannual scales (Rodway et al. 1993a, Burger 1995, Naslund and O'Donnell 1995, O'Donnell et al. 1995), and their measurement is subject to potentially large sources of bias (O'Donnell 1995). In addition, activity levels have never been calibrated to a measure of nesting density, and estimates of relative habitat use are speculative (Paton et al. 1992, Rodway et al. 1993b).

The association between activity levels and habitat use in small and isolated forest fragments, that are typical of the remaining habitat in the southern end of the species range, is easier to predict than the association found in extensive coastal watersheds, more common in British

Columbia and Alaska. In these areas it is difficult to distinguish activity of birds using an area from those flying past to other areas (Rodway et al. 1993a). More reliable estimates of habitat use are required by managers expected to set priorities for habitat protection in these watersheds.

Our objectives of this study were to: 1) determine the density of Marbled Murrelet nests in undisturbed, valley-bottom, old-growth forest habitat with high activity levels; 2) characterize the flood plain habitat we sampled in terms of forest structure thought to be important to nesting Marbled Murrelets; and 3) measure observer bias in identifying potential nest trees and estimating numbers of potential nesting platforms from the ground.

METHODS

We selected an area considered to be optimal breeding habitat for this study because it provided the best opportunity to obtain a reliable density estimate given the resources we had available, and because results from that area could be used as a baseline to compare densities in other areas and habitats. The study was conducted in the Ursus valley, Clayoquot Sound, British Columbia between 28 July - 12 August 1997. The study area was located at an elevation of 45-60 m, 8 km upstream from the estuary at the head of Bedwell Sound (see Burger 1997), and was confined to Sitka Spruce (*Picea sitchensis*) -

salmonberry (*Rubus spectabilis*) flood plain habitat in the Submontane Very Wet Maritime Variant of the Coastal Western Hemlock biogeoclimatic unit (Green and Klinka 1994). The trees, in which we searched for Marbled Murrelet nests, were climbed between 30 July-11 August 1997. Activity levels in the study area had been determined during intensive morning surveys (Ralph et al. 1994, RIC 1997) conducted in 1995, 1996 and 1997 (Burger et al. 1997, Rodway and Regehr unpubl. data). The main survey station in the middle of our study area had the highest detection rates of any station surveyed in the Ursus valley in 1995-96 (Burger et al. 1997), with maxima of 204 total and 59 occupied detections (behaviours thought to be associated with nesting; Paton 1995). Mean numbers of detections recorded during 23 surveys conducted in 1995-97 at 4 stations within the study area were 46.9 ± 9.3 total and 9.3 ± 16.5 occupied detections.

Sample plots ($N = 125$) were chosen randomly from a 320 x 2000 m grid, divided into 40 m squares, laid out along the valley bottom. Circular, 15 m radii, vegetation plots were surveyed at the centre of each of the 125 squares chosen randomly from the 400 squares in the grid. A 15 m radius for vegetation plots was chosen because preliminary exploration showed that that size of plot generally contained one or more trees with potential nest platforms, and because it insured that no

plots were contiguous within the 40x40 m segmented grid. Vegetation data and tree characteristics were collected following RIC (1997) protocol. Tree diameter at breast height (DBH) was measured to the nearest 0.1 cm with a dbh tape. Mistletoe (*Arceuthobium campylopodum*) infestation was ranked according to the following observed densities: 0 = none; 1 = light; and 2 = heavy, for the lower, middle and upper thirds of the tree, giving a maximum score of 6. Tree heights were estimated from the ground, and estimates were compared to a small sample of heights measured with a clinometer.

A potential nesting platform was defined as > 18 cm in diameter, including moss development or mistletoe infestation, and was located on a limb > 15 m above the forest floor (RIC 1997). All trees with potential nest platforms located within vegetation plots were identified, and the one closest to the centre of each plot was selected as a sample tree to be climbed. Trees were climbed only at random vegetation plots that contained trees with

platforms (i.e., trees outside vegetation plots were not considered). Characteristics of each tree climbed were recorded (Hamer and Naslund 1993).

Quality of platforms was evaluated by the tree climber (K.M. Jordan pers. comm.). Platforms were considered good potential Marbled Murrelet nest sites if they had adequate cover from above and easy access to murrelets flying in from the side, features common to most known nest sites (Hamer and Nelson 1995). We did not rate each individual platform, but rather rated each tree as having good potential nest sites if it contained at least one platform with these characteristics.

A proportion of sample plots fell partially or entirely on stream channel. Vegetation data were recorded at all plots that were <100% stream channel. Trees were climbed in partially vegetated plots that contained trees with potential nest platforms, so as not to bias our sample away from edge habitat. However, only plots that were entirely vegetated were used in calculations of tree densities and percent

cover. The proportion of plots that fell on stream channel was used to calculate the proportion of area in the entire grid that was not forested. Some plots fell on side slopes outside flood plain habitat and were excluded from the sample. Means are quoted ± 1 SD and are compared among tree species using 1-way ANOVA followed by Tukey post hoc comparisons.

RESULTS

Forested area in flood plain habitat comprised 60.9% of the 64 ha sample grid. Stream channel and side slopes made up 31.5 and 7.6% of the area, respectively. Canopy closure in flood plain forest was $40 \pm 12\%$, and percent cover of shrubs, herbs, and moss and lichens averaged 48 ± 21 , 34 ± 14 , and $39 \pm 19\%$, respectively, in 56, entirely vegetated, sample plots. Large, dominant conifers, Western Hemlock (*Tsuga heterophylla*) and Sitka Spruce, provided most potential nesting platforms available to Marbled Murrelets (Table 1).

Using the density of trees with potential nesting platforms (Table 1), and

TABLE 1. Mean (\pm SD) structural characteristics of flood plain Sitka Spruce - salmonberry forest habitat measured in 56 randomly located, 15 m radii, vegetation plots in Ursus valley, Clayoquot Sound in 1997. For each species, N = all trees measured for dbh and height; trees > 80 cm dbh measured for dbh and height; and trees with platforms measured for dbh and numbers of platforms per tree. All density estimates are means of 56, entirely vegetated, sample plots. Numbers of platforms per hectare for each tree species were calculated from the mean number of platforms counted per tree by the tree climber (see Table 2) and the density of trees with platforms.

	All trees			Trees >80 cm dbh			Trees with platforms		Total Platforms (#/ha)
	Density (#/ha)	DBH (cm)	Height (m)	Density (#/ha)	DBH (cm)	Height (m)	Density (#/ha)	DBH (cm)	
All species	223 (84)	44 (34)	24 (15)	36.4 (27)	114 (33)	50 (10)	35.4 (25)	103 (41)	475
<i>Tsuga heterophylla</i> (N=553;94;86)	102 (63)	47 (32)	27 (15)	19.5 (21)	103 (17)	47 (8)	16.4 (19)	92 (25)	148
<i>Picea sitchensis</i> (N=174;50;56)	23 (29)	64 (57)	29 (20)	8.1 (13)	141 (45)	55 (12)	9.3 (14)	132 (50)	277
<i>Abies amabilis</i> (N=152;32;23)	27 (52)	53 (30)	32 (17)	6.6 (18)	96 (14)	50 (9)	4.0 (9)	94 (19)	22
<i>Thuja plicata</i> (N=33;18;12)	3 (9)	98 (51)	39 (18)	1.3 (5)	137 (31)	52 (10)	0.5 (3)	144 (34)	3
<i>Acer macrophyllum</i> (N=65;3;11)	12 (19)	37 (21)	19 (9)	0.5 (3)	84 (3)	31 (9)	2.8 (7)	59 (15)	19
<i>Pseudotsuga menziesii</i> (N=5;3;4)	1 (4)	93 (57)	48 (26)	0.3 (2)	132 (21)	67 (3)	0.5 (4)	110 (48)	5
<i>Alnus rubra</i> (N=550;1;11)	55 (70)	29 (14)	18 (9)	0.3 (2)	86	35	1.8 (8)	58 (10)	2

the area of flood plain forest, we calculated that there were 1378 ± 963 trees with potential nesting platforms in the 64 ha sample area. We climbed 5.1% (70/1378) of all trees with platforms. No active or old nests were found in the 70 trees climbed (Table 2). Probabilities of this result for a range of hypothetical nesting densities, and assuming a random distribution of nests, are

given in Figure 1. For example, there is about a 5% chance of finding no nests in 70 trees climbed if the real nesting density is 4 nests per 100 trees with platforms. We can thus conclude with an acceptable level of confidence that nesting density in our study area is no greater than 4 nests per 100 trees with platforms, although it may be lower than this.

Numbers of potential nest platforms estimated from the ground were lower on average than actual counts of platforms by the tree climber (mean difference = 10 ± 17 ; $t_{69} = 4.93$, $P < 0.001$). Ground estimates were lower than climber counts for large trees with many platforms and greater than counts for those with few platforms (Fig. 2). Classification of trees as

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containing potential nesting platforms was accurate in all but one case. In that instance, platforms identified from the ground turned out to be <18 cm across. Estimated tree heights were not significantly different from measured heights (mean difference = -2.1 ± 7.9 m; $t_{11} = -0.92$, $P = 0.378$).

Numbers of platforms per tree were greater for Sitka Spruce than for other species ($F_{6,63} = 4.85$, $P < 0.001$; Tukey: $P_s < 0.05$ for Western Hemlock and Amabilis

Fir (*Abies amabilis*); Table 2). Sitka Spruce with platforms were taller ($F_{6,62} = 6.96$, $P < 0.001$; Tukey: $P < 0.001$) and had larger dbh ($F_{6,63} = 6.72$, $P < 0.001$; Tukey: $P < 0.001$) than Western Hemlock with platforms. Moss development was extensive on the limbs of all trees with platforms, and was less on Western Redcedar (*Thuja plicata*) than all other species ($F_{6,63} = 3.46$, $P = 0.005$; Tukey: $P_s < 0.05$). Depth of moss was greater on Sitka Spruce than Western Hemlock, and on

Broad-leaved Maple (*Acer macrophyllum*) than Western Hemlock, Amabilis Fir, and Western Redcedar ($F_{6,56} = 6.19$, $P < 0.001$; Tukey: $P_s < 0.05$). Mistletoe was more abundant on Western Hemlock than on Sitka Spruce ($F_{6,63} = 4.64$, $P = 0.001$; Tukey: $P < 0.001$).

Sitka Spruce had the greatest proportion of trees with good potential platforms providing adequate cover and easy access (Table 2). Platforms in the Western Redcedar, Broad-leaved Maple and

TABLE 2. Mean (\pm SD) structural characteristics of trees climbed to search for Marbled Murrelet nests in flood plain old-growth forest habitat in Ursus valley, Clayoquot Sound. Potential nesting platforms were > 18 cm in diameter, including moss, and were > 15 m above ground. Good platforms had cover from above and easy access to flying murrelets.

	N	DBH (cm)	Height (m)	Lichen (% cover)	Moss (% cover)	Moss depth (cm)	Mistletoe (code)	Platforms counted (N)	Platforms estimated (N)	Percent of trees with good platforms
All trees	70	112 (46)	51 (11)	8 (6)	92 (8)	4.5 (2.2)	0.7 (1.3)	16 (19)	6 (4)	43
<i>Tsuga heterophylla</i>	30	90 (23)	48 (8)	9 (6)	91 (8)	3.6 (1.4)	1.5 (1.6)	9 (5)	5 (3)	45
<i>Picea sitchensis</i>	26	146 (54)	58 (10)	6 (6)	94 (8)	5.5 (2.2)	0.1 (0.3)	30 (25)	9 (5)	58
<i>Abies amabilis</i>	6	97 (14)	49 (11)	10 (7)	94 (3)	3.5 (1.2)	0.3 (0.5)	6 (6)	5 (4)	17
<i>Acer macrophyllum</i>	3	61 (23)	30 (5)	1 (1)	100 (0)	8.7 (2.3)	0.0	7 (6)	5 (6)	0
<i>Thuja plicata</i>	2	145 (18)	49 (8)	18 (4)	73 (4)	2.5 (0)	0.0	5 (0)	2 (1)	0
<i>Pseudotsuga menziesii</i>	2	121 (8)	58 (0)	6 (6)	97 (3)	5.8 (1.1)	1.0 (1.4)	10 (1)	7 (0)	50
<i>Alnus rubra</i>	1	63	28	1	100	3.0	0.0	1	1	0

Red Alder trees that were climbed were considered poor potential nest sites because they were too exposed or had poor access.

DISCUSSION

Our study area was located in low elevation, unfragmented, old-growth forest, containing large trees with extensive epiphyte development on their limbs, and considered excellent Marbled Murrelet nesting habitat (Burger et al. 1995, 1997, papers in Ralph et al. 1995). High murrelet activity levels and frequent below-canopy detections over three years of surveys implicated the site as an important nesting area. Nests have been found in this area in 1998 (T.A. Chatwin, B.C. Ministry of Environment, Lands and Parks, pers. comm.) so we know that nesting does occur. Dominant conifers, Western Hemlock and Sitka Spruce, provided large numbers of potential nesting platforms, and have been the most important nest trees in coastal watersheds of British Columbia

(Jordan and Hughes 1995, Manley and Kelson 1995). Thus, we expect that our results provide a valid indication of the maximum, potential density of Marbled Murrelet nests in undisturbed, old-growth forest habitat in the region.

Evidence of old Marbled Murrelet nests may persist for one or more years after nesting (Hamer and Nelson 1995, Jordan and Hughes 1995, but see Naslund et al. 1995), and a proportion of old nests can be expected in an occupied stand. No recently active nests were found in the 70 trees climbed, a result that was unlikely to occur if the real nesting density was greater than 4 nests in 100 trees with platforms. Our results were even less likely to occur than indicated in Figure 1, if we consider the fact that no old nests were found either.

Western Hemlock was the most frequent tree species containing potential nesting platforms in the study area. However, Sitka Spruce, which was less common than Western Hemlock, were

larger in size, had thicker moss development on their limbs, and provided more potential platforms overall due to the larger number of platforms per tree. Proportion of trees rated as containing good potential nest sites, with adequate cover and access, was also higher for Sitka Spruce. These findings are consistent with the greater numbers of nests that have been found in Sitka Spruce than Western Hemlock in coastal, low-elevation forest in British Columbia (Hamer and Nelson 1995). Platforms in Amabilis Fir, Western Redcedar, Broad-leaved Maple, and Red Alder were generally too exposed or too difficult to access to be considered good potential nest sites. However, nests have been found in Western Redcedar trees in Washington and Oregon (Hamer and Nelson 1995, S.K. Nelson unpubl. data). Overall, 43% of trees with potential platforms contained good potential nest sites.

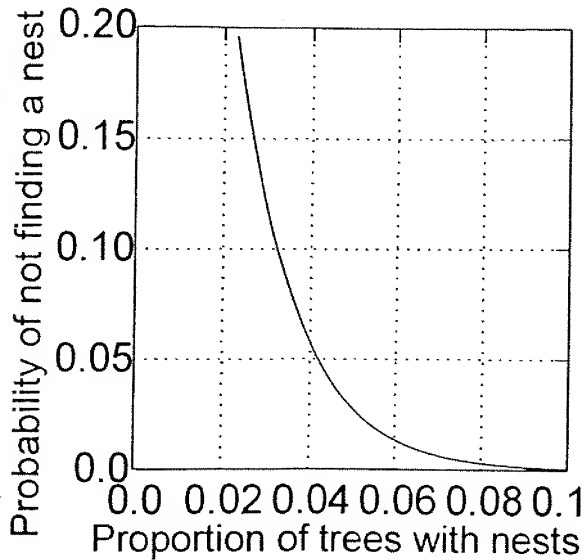


FIGURE 1. Probability of not finding a Marbled Murrelet nest in 70 random trees with potential nesting platforms for a range of hypothetical nesting densities. Hypothetical densities are given as the proportion of trees with platforms that contain nests. Probabilities assume a random nest distribution.

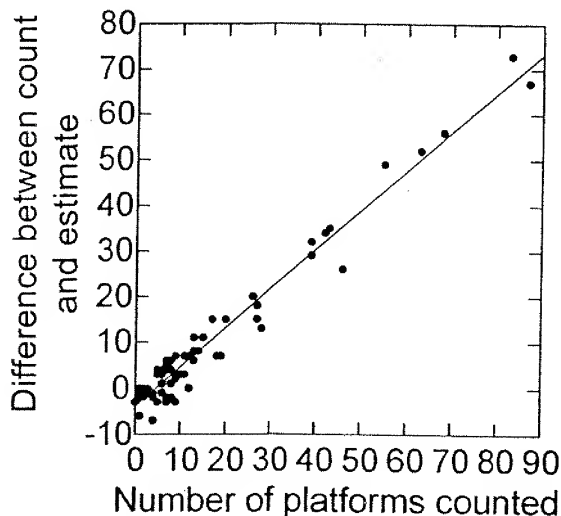


FIGURE 2. Error rate in estimating the number of potential Marbled Murrelet nesting platforms from the ground in relation to the numbers actually counted in the tree by a tree climber in Clayoquot Sound, British Columbia, 1997.

Ground observers tended to underestimate the number of platforms in trees that had many platforms and overestimate numbers in trees that contained

few platforms. Overall, numbers of platforms per tree averaged about three times greater than numbers estimated by ground observers. Differences between counted and estimated numbers were greatest for Sitka Spruce that had high mean numbers of platforms per tree. Differences between counted and estimated numbers would likely be less in habitats lacking Sitka Spruce as a dominant species.

The current density of Marbled Murrelet nests in the study area remains unknown. Our results do indicate that nesting density is probably low. This is an important conclusion related to habitat protection for the species. Many studies have demonstrated highest activity levels and occupied behaviours in low-elevation, old-growth forest habitat (papers in Ralph et al. 1995). Low nesting densities means that large tracts of such habitat are required to protect viable breeding populations. Further studies, in which a greater proportion of potential nest trees are climbed in a variety of habitats, are needed to determine actual nesting densities and estimate areas of old-growth forest required to protect established populations.

Management decisions for these areas should be postponed until these data are available, as there are few opportunities remaining to investigate the distribution of breeding Marbled Murrelets in undisturbed watersheds. Nesting densities determined in representative sample plots, in

conjunction with radar estimates of the numbers of Marbled Murrelets using a watershed (Burger 1997), would provide reliable data on habitat use patterns, and facilitate confident decisions on habitat requirements for the species.

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EFFORTS TO PROTECT NESTING SEABIRDS DURING LORAN TOWER DEMOLITION AT JOHNSTON ATOLL

By Donna L. O'Daniel

Abstract: The Long Range Aid to Navigation (LORAN) tower on Sand Island, Johnston Atoll, was demolished on 3 Dec. 1992. Twenty-six pairs of Great Frigatebirds *Fregata minor* and four pairs of Brown Boobies *Sula leucogaster* were in danger of being lost by the falling tower and guy wires. Eggs and nestlings were protected by temporarily removing them from the area of impact; dummy eggs were inserted in nests to keep adults from deserting. These actions prevented mortality and nest failure in Great Frigatebirds, but two Brown Booby nests were deserted. We also scared adults with dummy charges before the actual demolition. With foresight, managers of seabird colonies dealing with situations of this type may be able to minimize effects on breeding seabirds.

INTRODUCTION

Johnston Atoll (16°45'N, 169°31'W), ~1300 km southwest of Honolulu, Hawaii, was declared a bird refuge in 1926, a restricted military base in 1933, and a National Wildlife Refuge in 1940. In 1957 the U. S. Coast Guard (USCG) constructed a 625-foot Long Range Aid to Navigation (LORAN) tower on Sand Island, one of four islands in the atoll, as part of a navigational system for the central Pacific region. Satellite and global positioning navigation systems have recently made LORAN stations obsolete. Therefore, the USCG contracted a U. S. Army Demolition Team to demolish the Sand Island LORAN tower in 1992. Nine species of seabirds nest on Sand Island within range of the tower and its 26 guy wires. Because the breeding season occurs mostly from January to late November, the USCG and USFWS set a demolition date of 3 December 1992 to minimize effects of demolition on breeding bird populations.

However, in December 1992, two species of seabirds were nesting on Sand Island (Fig. 1): Great Frigatebird and Brown Booby. Twenty-two of the 26 Great Frigatebird nests contained eggs, one a hatching egg, and the remainder young nestlings. All four Brown Booby nests contained eggs. Nests of both species were in danger of being hit by the falling tower and guy wires.

PREPARATION FOR THE DEMOLITION

The plan called for setting charges at the base of key supporting guy wires and the tower. Upon detonation, the tower was expected to fall to the southeast; the guy wires were expected to fall along a line from their anchor point in the coral to the base of the tower.

Two days before demolition, the location and contents of each Great Frigate-

bird and Brown Booby nest were noted. On the demolition date, two hours before charges were to go off, we removed eggs and nestlings from all nests. These were transported in cardboard boxes with compartments identifying the nest from which each was taken to a building out of range of the tower (Figure 1). Each egg was replaced with a hard-boiled chicken egg. Most frigatebirds remained on their nests during this process, but the boobies left at our approach. A heating pad, set on low and covered with a towel, was placed in the bottom of each box containing eggs and nestlings to provide warmth; eggs and nestlings were monitored every 10 minutes.

One minute prior to the explosion, a dummy charge was detonated which caused all adults to fly off nests. The actual charge, scheduled for detonation ~1 minute later to fell the tower, malfunctioned; instead, demolition occurred 1.5 hours later, when most frigatebirds and boobies were back on nests. The tower fell to the southeast; neither it nor the guy wires hit any nests or birds.

EVENTS FOLLOWING DEMOLITION

Fifteen minutes after the tower fell, we returned all eggs to nests.

Two frigatebird nests with nestlings and the one with a hatching egg were unattended by nightfall, so chicken eggs were placed in each nest to lure adults back. The next morning, each nest contained an adult (incubating a chicken egg). The adult frigatebirds did not leave nests when chicken eggs were removed and replaced by chicks.

To our knowledge, there were no Great Frigatebird eggs or nestlings lost as a direct result of disturbance caused by their removal and replacement or by the tower demolition itself (two eggs in two nests, however, failed to hatch). None of

the Brown Booby nests were destroyed by the demolition, but two days later, both nests on the east side of the island were deserted.

DISCUSSION

Although Great Frigatebird eggs are larger ($x=71.29$ [l] \times 47.71 mm [w]; $n=83$; E. A. Schreiber, unpubl.) than chicken eggs ($x=58.8$ [l] \times 44.6 mm [w]; $n=12$), chicken eggs were readily accepted by incubating adults. Medway (1961) found that pigeons would accept a dummy egg of a different shape and size, and also that acceptance was dependent on the continual presence of eggs in nests to maintain incubation behavior. Dummy eggs not only kept incubating adults on their nests, they also lured adults with chicks back to their nests. It is possible that the chicken eggs acted as visual and tactile stimuli to draw adults to nests. This phenomenon has been observed in other species of birds including Sooty Tern *Sterna fuscata* (Flint 1984), Black-headed Gull *Larus ridibundus* (Beer 1966), and Ring-billed Gull *Larus delawarensis* (Emlen and Miller 1969).

Overall reproductive success of Great Frigatebirds on Sand Island in 1992 was 54%. In the northwest Hawaiian Islands, Harrison (1990) found that only about one-third of the birds were successful in their nesting attempts. Thus, although the reproductive success of the frigatebirds on Johnston Atoll had not been measured prior to 1992, it did not appear to suffer because of the demolition.

In conclusion, the methods used herein could apply to any situation where temporary removal of eggs/chicks is necessary to minimize disturbance, for instance when restoring seabird habitat through removal of human debris, etc.

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[This is a peer reviewed article.]

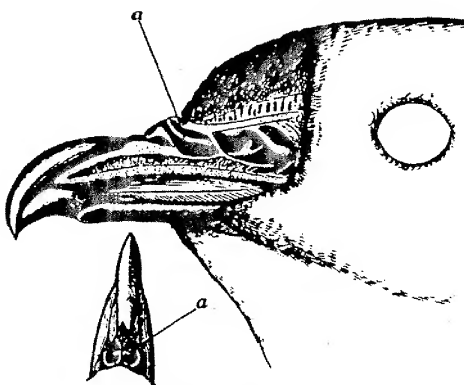


Fig. 1. Sagittal section through the left narial passage, and dorsal view of the bill, of *Pelecanoides garnoti*, showing the paraseptal process (a).

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CONSERVATION NEWS

By Craig S. Harrison

MOST OF WORLD'S LARGEST CASPIAN TERN COLONY TO BE DESTROYED

As reported last issue ("Federal Government Poised to Destroy Largest Caspian Tern Colony in North America," *Pacific Seabirds* 25: 69-70), state and federal agencies have developed plans to destroy the nesting habitat of the largest Caspian tern colony in the world at Rice Island, Columbia River estuary. The colony has grown to about 10,000 pairs, about 30% of the North American population. Much of their diet consists of hatchery-raised smolts of ESA listed coho salmon and steelhead populations, and the National Marine Fisheries Service (NMFS) blames terns for the non-recovery of these populations.

PSG sent a Freedom of Information Act request to NMFS asking for data on the past twenty years on the percentage of smolts that have returned each year to spawn in the Columbia River system. The information that we received is very difficult to use for this purpose. The Corps issued a draft environmental assessment for its proposal to destroy the colony while attempting to create new nesting habitat closer to the Pacific Ocean. PSG filed comments in late November, asking the Corps to leave at least 4 acres of nesting habitat on Rice Island until it could be determined that the new habitat is acceptable to terns. The Corps largely ignored PSG's comments and issued a final determination to destroy all but one acre this winter, stating that this action does not significantly affect the environment and requires no Environmental Impact Statement. The Corps intends to vegetate or otherwise render unusable all but one acre of the eight acre colony and disturb Caspian terns that attempt to nest there. It will try to relocate the colony to East Sand Island, 16 miles closer to the ocean, by developing 16 acres of nesting habitat, placing decoys and playing taped vocalizations there, as well as controlling gulls.

Apparently at least half of the 8 acres of habitat "created" on East Sand Island contain standing water where terns will

not nest. Nevertheless, the Corps has continued its destruction of the nesting habitat at Rice Island. PSG has asked FWS to immediately draft and implement a regional plan to restore colonies formerly occupied by Caspian terns in Washington and Oregon. If there is a widespread nesting failure of this population, as now seems possible, the listing of this species under the Endangered Species Act may be warranted.

Currently, Rice Island is the only Caspian tern colony in coastal Oregon and Washington. This has not always been the case. Since 1957, the region has seen the loss of 6 colonies, three in Grays Harbor, one in Willapa Bay, one in Puget Sound and now Rice Island. Federal agencies forced terns to leave colonies at Everett Naval Station and at East Sand Island. The others have been lost due to encroachment of human activities on the sandy islands required by the species. Rice Island, an artificial island composed of dredged materials, is typical habitat for this species throughout its North American range because much of its natural nesting habitat has disappeared. In this regard, managing Caspian terns, like waterfowl, requires intensive habitat management.

ALASKA AND HAWAII LONGLINE FISHERY REGULATIONS

Thanks to the American Bird Conservancy, PSG attended a meeting with the director of NMFS in January 1999. ABC and PSG urged improvements in the Alaska longline fishing regulations. PSG stated that it had supported NMFS's proposed regulations in 1997 with the understanding that NMFS would revise the rules after it had assessed scientifically the effectiveness of the various by-catch methods. Because NMFS has not conducted a study, PSG sent a Freedom of Information Act request in December to obtain information about what NMFS was doing. The director announced at our meeting that NMFS would fund a study on by-catch methods, and the North Pa-

cific Fishery Management Council seems interested in improving longline regulations.

PSG has also continued to urge NMFS to adopt regulations that require seabird avoidance techniques in the longline fisheries off Hawaii. In December, PSG filed a Freedom of Information Act request with the NMFS Honolulu Laboratory to obtain information about what it is doing on this issue. NMFS still has not proposed longline regulations, but the director announced at the January meeting that it is in the process of consulting with FWS under the Endangered Species Act with regard to bycatch of short-tailed albatross in this fishery. Moreover, the Western Pacific Fisheries Management Council seems to be moving toward proposing by-catch regulations.

WASHINGTON STATE - CANADA GILLNET FISHERY ISSUES

Thanks to Ed Melvin and Julia Parish, PSG wrote in April 1998 to the director of FWS, the Pacific Salmon Commission, the Northwest Indian Fisheries Commission, the Canadian Minister of Fisheries and Oceans, the Canadian Minister of the Environment, the British Columbia Minister of Environment and the Governor of the State of Washington concerning the bycatch of common murre and rhinoceros auklets in the driftnet fisheries in the waters of British Columbia and Washington (Puget Sound, the Strait of Georgia, Johnstone Strait, the Vancouver Island coast, and Queen Charlotte Strait).

PSG requested that (1) these fisheries be monitored through on-board observer programs to determine the rate and magnitude of seabird bycatch by species (2) measures be taken to develop tools to minimize this bycatch and (3) seabird bycatch reduction tools and strategies be incorporated into management of these fisheries. Responses to PSG's letter drifted in throughout 1998. Among the barriers to resolving this issue are a perception that the State of Washington has

done most of the heavy lifting; Washington's rules apply to non-treaty fishing fleet and not the tribal fleet; and the question of the extent to which Canadian fisheries contribute to this problem. A USA-Canadian NAFTA meeting in November addressed this issue, possibly one benefit of PSG's efforts.

GLOBAL SEABIRD ACCORD RATIFIED BY FAO

The United Nation's Food and Agriculture Organization (FAO) Committee on Fisheries approved in February 1999 the international accord designed to greatly reduce or eliminate the killing of seabirds on hooks set by longline fishing vessels. It approved a plan that would have fishing nations develop plans of action specifying how they will act to eliminate seabird bycatch. This is a great improvement from the status quo, but imperfect. Implementation is voluntary, and the utility of the measures will not be determined until fishing nations develop and implement their national plans. This issue will require attention by PSG for years.

PSG worked hard to persuade the FAO to establish these protocols. Efforts included meeting with and writing comments to the U.S. Department of the Interior and NOAA/NMFS to encourage the USA to endorse strong measures in the FAO meetings. PSG also asked EXCo members Tony Gaston and Mark Tasker to communicate with officials in Canada and UK on this issue. Among other things, we encouraged protecting all seabirds -- not just those already endangered or threatened -- so that common seabird species remain common.

THREATENED NEWELL'S SHEARWATERS NEED ACTIVE MANAGEMENT

Listed as a threatened species in 1975, Newell's shearwaters breed only in the main Hawaiian Islands. Since peaking in 1987, the number of chicks on Kauai counted by the Save Our Shearwaters Program (an index of population size and success) has declined by about 75%. Anecdotal information from the Island of Hawaii indicates that several cinder cones that harbor the few remaining populations

on that island have been mined recently, destroying them. PSG asked FWS to implement the 1983 recovery plan for this species, including conducting surveys to locate nesting sites and controlling predators near colonies.

FWS responded that information concerning the status of the populations on the cinder cones was sparse, and that the Service would attempt to obtain permission from private land owners to conduct surveys for this species. FWS committed to conducting surveys to refine our knowledge of the nesting and population trends, and to update the recovery plan. There was no commitment to implement the recovery plan, and decisions concerning critical habitat and elevating some populations from threatened to endangered status await an evaluation of additional information.

Unfortunately, recent follow-up with FWS indicates that it will make no major efforts concerning the management of Newell's shearwaters this year. If FWS continues to fail to devote sufficient resources to manage this species, it may become necessary to file a petition to designate critical habitat or to list the populations on the islands of Hawaii, Molokai and Lanai as endangered.

SNOWY PLOVER TO GET CRITICAL HABITAT

A federal judge ruled the FWS must designate critical habitat for the threatened western snowy plover by December 1999. As reported previously (see "Litigation May Force FWS to Designate More Critical Habitat," *Pacific Seabirds* 24:74-75), the decision in *Natural Resources Defense Council v. U.S. Department of Interior*, 113 F.3d 1121 (9th Cir. 1997) has widespread consequences for designating critical habitat for listed species. The federal court ruled that FWS was not implementing the Endangered Species Act, which requires that the Service designate critical habitat concurrently with listing a species "to the maximum extent prudent and determinable." In contravention of the requirements of the Act, FWS has refused to designate critical habitat for most listed species. When FWS listed the snowy plover in 1993, the Service said it could not list critical habitat. The number of nesting areas along the Pacific coast of the USA may have declined in the past 20 years by

over 50% and 75%, respectively, in California and Oregon.

CONGRESS CONSIDERS HISTORIC FUNDING SOURCE FOR STATE NONGAME WILDLIFE PROGRAMS

The Conservation and Reinvestment Act of 1999 (CARA, H.R. 701 and S. 25) has been reintroduced as a major legislative priority of its lead sponsors. With 43 co-sponsors from both parties in the House and Senate, CARA proposes to give states over \$2 billion annually in federal outer continental shelf oil and gas revenue to permanently fund: (1) coastal restoration; (2) land-based conservation and recreation; and (3) wildlife conservation.

Bird conservation efforts stand to benefit substantially from all three. The wildlife conservation component would provide state fish and wildlife agencies with resources to address the needs of declining bird species and to identify and restore critical bird habitats. Approximate new funds that would be available to state nongame programs would be: Washington (\$8.5 million); Oregon (\$8.4 million); California (\$22.9 million); Hawaii (\$2.3 million). The coastal restoration component would enable coastal states to restore coastal habitat and associated animal species. Full funding of the Land & Water Conservation Fund would let states and the federal government protect key habitat for migratory birds. The legislation could arrive on the House and Senate floors for a full vote this summer. For more information, see www.teaming.com; e-mail teaming@sso.org or call 202-624-7890.

PSG EVALUATES STATUS OF THREATENED AND ENDANGERED SEABIRDS

PSG's Conservation Committee has been coordinating an evaluation of Bird-Life International's draft species accounts on seabird species that are endangered or threatened. The species include sooty storm-petrel, ashy storm-petrel, short-tailed albatross, black-footed albatross, Hawaiian petrel, Juan Fernandez petrel, Townsend's shearwater, black-vented

CONSERVATION NEWS

shearwater, Newell's shearwater, Guadalupe storm-petrel, Heerman's gull, red-legged kittiwake, elegant tern, marbled murrelet, Xantus' murrelet, and Craveri's murrelet. PSG also provided information on the Polynesian storm-petrel, Phoenix petrel and Fiji petrel. David Ainley, Dan Anderson, Vern Byrd, David Duffy, Bill Everett, Beth Flint, Kim Nelson, Mark Rauzon, Art SOWls, and Bill Sydeman have each assisted in this effort.

RUSSIAN NAVY BOMBS SEABIRD COLONIES

In late March, Russian battleships and MIG jets began attempts to bomb Bolshoi Pelis, an uninhabited island located in Primorye State Marine Reserve near Vladivostok. Although Pyotr Kolmakov, director of the southern reserve, persuaded the navy to pull back from the reserve, it merely redirected its efforts to nearby islands. Apparently bombs and torpedoes were fired at Karamzin which is deemed a "monument of nature" by the Russian federal government.

The Russian Pacific Fleet claims that it has the legal right to hold maneuvers in Peter the Great Gulf and the Bolshoi Pelis

Island area. In 1999, for the first time, the fleet asked the State Committee for the Environment for permission to conduct exercises using live ordnance on several islands. Committee spokeswoman Natalya Myasoyedova said the navy ignored its decision and is damaging the reserve. Seabird biologist Natalya Litvinenko has been a critic of the maneuvers since 1970, when the navy began firing without warning while she was studying birds on Karamzin. Karamzin is home to 150 pairs of locally endangered streaked shearwaters, rare black-tailed gulls and Chinese egrets. "The entire island was covered with a bloody mash of birds," she said. "I was covered all over with birds' blood. I found a crevice in the rock and hid there until it stopped." Myasoyedova, the spokeswoman for the Committee to Protect the Environment, said her federal organization can do nothing about the bombing.

NEW PESTICIDES AND BIRDS CAMPAIGN

With the hiring of Kelley Tucker, the American Bird Conservancy has launched its Pesticides and Birds Campaign, fo-

cusing on creating broad public awareness of the problem of wildlife pesticide poisonings. The campaign's mission is to reduce wild birds' risk of exposure to pesticides that can be proven to have lethal and sub-lethal effects when used according to law and accepted practice. Tucker will focus on building cooperative relationships among conservation organizations, government agencies, commercial concerns, research institutions, animal welfare groups and other stakeholders. Campaign goals include working with government agencies to strengthen wildlife protection in pesticides management and regulation; conducting a public campaign against the "Fatal Five" pesticides routinely killing birds in the U.S.; building cooperative relationships with pesticide companies; and establishing a pesticide incident reporting system. The program will be guided by an advisory council of wildlife toxicologists, regulatory authorities and other specialists. For more information, contact KelleyTucker at 202-778-9773 or ktucker@abcbirds.org

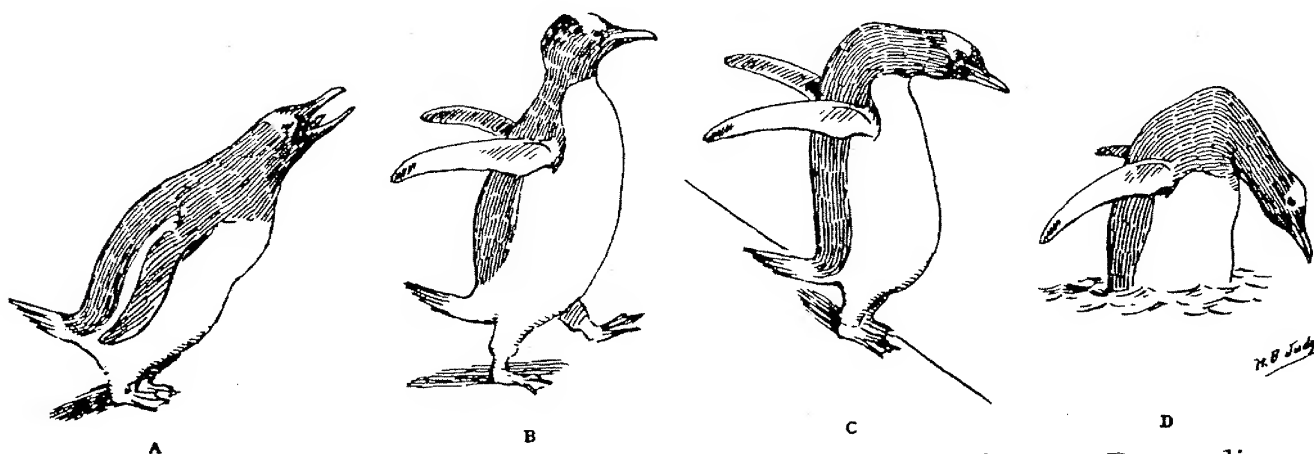


Fig. 3. a. Trumpeting. b. Walking on level ground. c. Descending a bank. d. Wading into the water.

From. Murphy, R.C. 1915. The penguins of South Georgia. The Museum of the Brooklyn Institute of Arts and Sciences, Science Bulletin 2(5): 1-133. Page 125.

PSG NEWS

JOHN WARHAM RECIPIENT OF PSG LIFETIME ACHIEVEMENT AWARD, 1999

By David G. Ainley

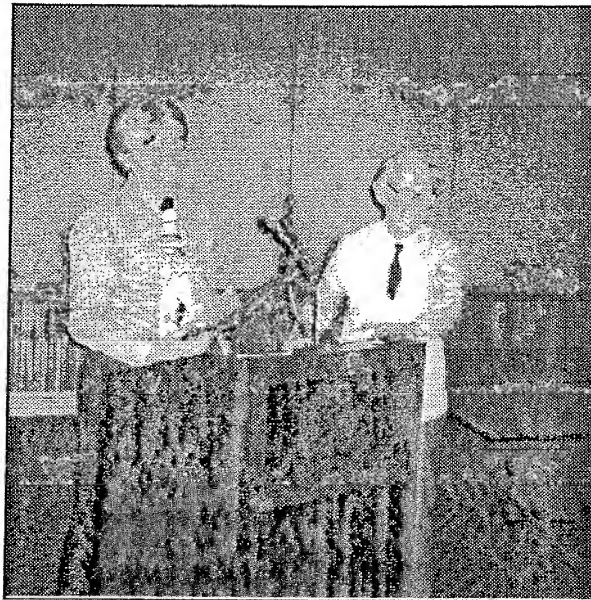
Thanks to the idealism that was rampant throughout the U.S. and elsewhere during the 1960s and early 1970s, coming into being was a series of environmental laws and regulations upon which PSG owes its existence. To name a few of these, the Outer Continental Shelf Lands Act, Endangered Species Act and Clean Water Act. If you take a minute to review a program from any PSG annual meeting, it becomes readily apparent that the large majority of presentations grew from research that was a response to an oil spill, an endangered species recovery plan, or of a similar bent. In other words, PSG members mostly have been involved in the management part of the organization's mission statement.

To grasp, though, the significance of what John Warham has contributed to us, for a moment at least, you have to change your frame of reference from the totally practical perspective. You must do this to envision a world in which seabird research is driven only by an insatiable thirst for knowledge, a thirst for exploration of the uncharted waters that lie at the edge of our perceptions. This thirst is what has propelled John Warham throughout his career.

John began his life in England and early on explored the natural world, his life long avocation. He landed the first of his few real jobs in 1937 at the ripe age of 18 years. His job was that of a laboratory assistant in a textile plant. He had designs of pursuing a degree in color chemistry to further that career, but that plan was derailed quickly by World War II. He spent the next 6.5 years in the British army, leaving that occupation with the rank of Captain only with the end of battle in 1946. One accomplishment during that period was marrying Pat Sabido, his life long companion. As the British would put it, John was "demobilized" from the army, but lacking

mobility is not a characteristic of this person.

John returned to his first job and quickly rose to a managerial level. Not long after, he published his first work in natural history, a book on the birds of Sherwood Forest, entitled "Bird Watcher's Delight" (Country Life, London; 1951). At this time, the Warhams suffered a mutual mid-life crisis. Recognizing that the world's wildlife were in jeopardy, they forsook the normal life and



John Warham (right) receives Pacific Seabird Group Lifetime Achievement Award from David Ainley during the 1999 annual meeting in Washington.

became vagabonds to travel at the periphery of civilization. For the next 12 years or so, they visited the wilds of Australia, living on fees gained from natural history writing and photographs published in the popular press.

During this period they visited many offshore islands. Included was a 15-month stint by John as a biologist on Macquarie Island working for the Australian National Antarctic Expedition. Also during this period, John managed to publish his second book, "The Technique of Bird Photography", now in its fourth

printing (Focal Press, London & New York; 1956, 1966, 1973, 1983).

In 1961, the Warhams returned to Britain where John finally began pursuit of his first degree, that of Bachelor of Science at Durham University. By this time, he had published not just the two books, but 35 scientific papers, mostly regarding seabirds. These contributions were not just notes in regional journals, but included several in major journals, for example, "The breeding of the Great-winged Petrel, *Pterodroma macroptera* (Ibis, 1956) or "The breeding of the Flesh-footed Shearwater, *Puffinus carneipes*" (Auk, 1958).

John finished his BS in 1965, after a four-year period in which he also published an additional 14 papers (!), including "The biology of the Giant Petrel, *Macronectes giganteus*" (Auk, 1962) and "The Rockhopper Penguin, *Eudyptes chrysocome*, at Macquarie Island (Auk, 1963). Three years later, 1968, he finished his MSc at Durham, an activity that slowed his publications to six, but which included "The White-headed Petrel *Pterodroma lessoni* at Macquarie Island" (Emu, 1967).

At this point, the Warhams broke camp again to move to Christchurch, New Zealand. Here John accepted his second real job, that of Lecturer in Zoology at the University of Canterbury, and Pat continued her career in nursing, as well as an 18-year stint as President of the Herb Society of Christchurch. At this time, John began working, too, toward a PhD, which would involve a comparative study of the breeding biology of the crested penguins (*Eudyptes*). John had gathered information on Royal and Rockhopper Penguins while at Macquarie, but to continue with this study required mounting expeditions to such places as the Antipodes, Snares and Campbell islands, where he encountered such species as the Erect-crested and

the Snares Crested penguins. Toward his research ends, he also purchased in 1967 a Ford stationwagon in order to make the long, arduous trips from Christchurch to Fiordland to study the Fiordland Crested Penguin. To this day, the Warhams still drive that Ford, as John says, one of his contributions to the conservation of Earth's resources.

In 1973, John attained his PhD. In the meantime, he published 12 more papers, mostly on crested penguins, as well as co-authoring a book, with D.L. & V.N. Serventy, *The Handbook of Australian Sea-birds* (Reed, Sydney, 1971). As with R.C. Murphy's, *The Oceanic Birds of South America* (Macmillan, NY; 1936), this book on seabirds of the seas surrounding Australia is a must reference for all seabird biologists.

By the mid-1970s, after a flurry of additional penguin papers, he began to turn his attention more and more to investigations and writings about his most favorite group of birds, the procellariiformes. Over the years, John, often accompanied by Pat, visited numerous breeding sites of petrels, including such places as Skomer, off Wales; Norfolk, Lord Howe

and other islands in the southwest Pacific; the smaller islands around Australia and New Zealand; and finally Midway and Kauai in the central Pacific. Where ever he went, he observed with a keen eye and made copious notes. Now he began the task of bringing his ideas about the biology of petrels and albatrosses to light. It's a task that continues to this day.

Just 12 years after receiving his PhD, John retired from his university job. But retired in the larger sense he was not! Since his retirement in 1985, John has published 20 more papers (the total currently stands at 125). More importantly, he produced the work of his life, a magnificent two-volume treatise on the natural history of the procellariiformes: *The Petrels: Their Ecology and Breeding Systems* (1990) and *The Behaviour, Population Biology and Physiology of the Petrels* (1996), both published by Academic Press. Accompanying this set, and available to us all on the internet, is a 13,000 entry bibliography of the petrels, including obscure references dating back to the Dark Ages.

John Warham has been blessed with a keen eye, an encyclopedic memory, an

adventurous spirit and a desire to share his discoveries widely. In 1997, Steven Ambrose wrote a book entitled, *Undaunted Courage*, which chronicles the life of another person cast in the same mold as John Warham. That person is Meriweather Lewis. Like Lewis, John Warham has been driven to explore the uncharted territories, expanding the human experience. Like Lewis, too, Warham has been driven to record accurately, with great perception, what his eyes had seen and his mind had reasoned, usually correctly. Thomas Jefferson wrote of Meriweather Lewis that he embodied the spirit of the Enlightenment, an age in which information is the key, because information not recorded is information lost. John Warham has been an incredible source of information and the world is a much better place that he has shared it all with us. For that, the Pacific Seabird Group honors him with the Lifetime Achievement Award. We owe him much, much more.

David Ainley, H.T. Harvey & Associates,
P.O. Box 1180, Alviso CA 95002 USA.

PACIFIC SEABIRD GROUP 2000 ANNUAL MEETING - NAPA, CALIFORNIA



TWENTY SEVENTH ANNUAL MEETING
23-26 FEBRUARY 2000

The Twenty Seventh Annual Meeting of the Pacific Seabird Group will be held 23-26 February 2000, at the Napa Valley Marriott, California. Contact Ken Brigg, of the local committee for additional information: E-mail: ktbriggs@msn.com, Telephone: (925) 837-4264 Details will be posted on the PSG web site as arrangements for the meeting develop.

CONSULT THE PSG WEB SITE FOR THE MEETING TIME SCHEDULE, PAPER AND POSTER SESSIONS, COMMITTEE MEETINGS, SOCIAL EVENTS, AND PAPER ABSTRACTS AS THEY BECOME AVAILABLE

IN MEMORIAM: Charles Joseph Guiguet

By Harry R. Carter

On 11 November 1995 at the joint meeting of the Pacific Seabird Group (PSG) and the Colonial Waterbird Society (CWS) in Victoria, British Columbia (B.C.), Charles Joseph Guiguet was awarded the Lifetime Achievement Award by PSG. At the presentation, Guiguet's many achievements were summarized and a 1950 film called "Nature's Outpost - Triangle Island" was shown which captured Guiguet studying seabirds in the field. Guiguet was a pioneer vertebrate biologist in B.C. and served as biologist and curator of the Birds and Mammals

Division at the B.C. Provincial Museum (BCPM; now the Royal B.C. Museum) from 1948-1980. His efforts to better determine the distribution of birds and mammals in B.C. led him to remote coastal areas where his collections and observations in the 1940s and 1950s led to the discovery and first insights into the vast populations of breeding seabirds in B.C., mostly hidden on isolated, forested islands shrouded in mist.

He further conducted some of the earliest studies of the Marbled Murrelet, a seabird which nests in old-growth forests threatened by logging, and produced a widely-respected series of BCPM handbooks on the "Birds of B.C."

At the end of World War II in 1945, Guiguet (at age 30) returned to Vancouver, B.C., after distinguished service in Europe for the Canadian and Royal Air Forces. He returned to zoological studies at the University of British Columbia (UBC) where he had previously been associated with Professor Ian McTaggart-

Cowan. In 1948, he was hired as a biologist by the BCPM in Victoria, B.C. Efforts to study birds and mammals had waned at the BCPM during the war, and since McTaggart-Cowan's departure from the BCPM to UBC in 1940. Guiguet was to build the bird and mammal collections and expand the knowledge of the vertebrate fauna of B.C., beyond the then recent "Review of the Bird Fauna of British Columbia" by Munro and Cowan (1947). In 1946-1947, 1952 and 1959, he travelled to the remote Queen Charlotte Is-

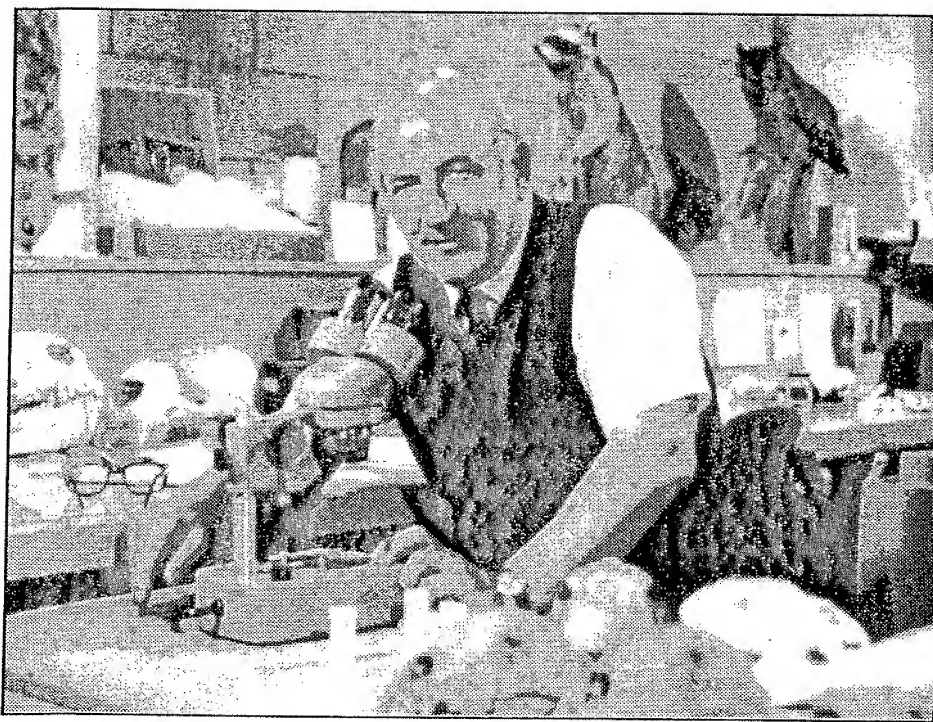
land off the northwestern tip of Vancouver Island (Carl et al. 1951).

In these and other coastal areas, often alone and with little support, Guiguet spent much time discovering and investigating the extensive populations of seabirds breeding on remote B.C. islands which we now know hold most of the world's Ancient Murrelets, Cassin's Auklets and Rhinoceros Auklets. His collections and field notes were used extensively in the "Catalogue of British Columbia Sea-bird Colonies" by Drent

and Guiguet (1961). While UBC Professor Rudy Drent and his students were conducting detailed studies of seabirds at Mandarte Island and other nearby Gulf Islands, information for the rest of the province's vast coasts was available almost entirely from the widely-traveled Guiguet. For many islands and species, Guiguet had noted either the first nesting in the province or provided the first verification and description of nesting since early records by

egg collectors at the turn of the century (Guiguet 1950a, 1971; Drent and Guiguet 1961; Campbell et al. 1990). The "Catalogue" was the forerunner of large-scale efforts since the 1960s to document and monitor seabird colonies in B.C. and along the Pacific coast from Alaska to California. Guiguet's notes also have been used extensively by Campbell et al. (1990) and Rodway (1991) in their summations of the known history of seabird colonies in B.C.

Guiguet also became enthralled with the little known Marbled Murrelet during



Charles Guiguet examining specimens in the Birds and Mammals Division of the British Columbia Provincial Museum, Victoria, B.C., circa 1970.

lands, at times with his wife Muriel or McTaggart-Cowan, to collect island-endemic birds and mammals for the UBC and BCPM collections. He became well acquainted with naturalist Ronald Stewart at Massett. In 1948-1949, he travelled to the desolate Goose Islands, off the north mainland coast, where he completed his UBC Master's studies (Guiguet 1953) and worked closely with biologist Pat Martin. In 1949-1950, Guiguet travelled with BCPM biologists G. Clifford Carl, George Hardy, and Frank Beebe to investigate the Scott Island Group, including Triangle

collecting trips in the Queen Charlotte Islands and he observed these mysterious birds throughout B.C. coastal waters and flying inland over forested areas. He also collated data from other observers to produce several important articles, including a famous one titled "The Enigma of the Pacific" (Guiguet 1956). In these articles, he provided many clues for future researchers to discover inland nesting in old-growth forests, including observations of nests, eggs collected from oviducts, and discoveries of downy young and fledglings at inland localities. In retrospect, Guiguet reported the first tree nest of a Marbled Murrelet in the world, based on the discovery by Walter Feyer of an adult and broken eggshells in a felled hemlock near Masset in 1953. Guiguet's observations and papers were instrumental in the original deductions that Marbled Murrelets nest primarily in old-growth forests (Guiguet 1950b, 1971, Sealy and Carter 1984). This assertion has fueled the recent (since the late 1980s) onslaught of research on Marbled Murrelets to fully demonstrate this fact and to congeal our concerns about the effects of logging on this species all along the Pacific coast from Alaska to California.

From 1954-1983, Guiguet produced a series of 10 BCPM handbooks on the birds of B.C. In addition, he co-authored the extensive and well-known handbook on the "Mammals of B.C." with McTaggart-Cowan (Cowan and Guiguet 1956). Together, these handbooks provided a more complete coverage of the natural history and distribution of seabirds (Guiguet 1957, 1972), waterfowl (Guiguet 1958), shorebirds (Guiguet 1955) and other birds (see citations in Campbell et al. 1990), based in his own intimate understanding of wildlife from decades of collecting and observing. Even today, these handbooks are used widely by both birdwatchers and experienced researchers, often providing important data on little known aspects of natural history. For many decades, these handbooks filled the gap between Munro and Cowan (1947) and Campbell et al. (1990), other large summaries of information on birds in B.C.

In 1969, Guiguet oversaw the transition of the Birds and Mammals Division of the B.C. Provincial Museum from the cramped quarters in the east wing of the Parliament Buildings to their current structure and site next door. He hired many biologists, including R. Wayne Campbell (later the lead author for the recent amazing compendium on the

"Birds of B.C." [Campbell et al. 1990]), and oversaw the expanded division during the 1970s which conducted many expeditions to better understand the bird and mammal fauna of B.C., including the first complete surveys of seabird colonies in B.C. in 1975-1977. He strongly influenced the lives and careers of many colleagues and budding biologists during his tenure. Guiguet retired in 1980 and, with wife Muriel and their extended family, leads an active life in Victoria. The Guiguets are well known for their fishing prowess. Charles' classic wooden boat *The Pride of the Fleet*, which had a commercial license for many years, still plies the waters of Oak Bay as it has for over 45 years.

Space constraints prevent a complete description of this remarkable individual's life and overall contributions to the knowledge of birds and mammals in B.C. Refer to Campbell et al. (1990) for a recent citation list for Guiguet's many publications. Mortimore (1954) provides other important details on Guiguet's life. This brief summary on his contributions related to seabirds has benefitted from the comments and efforts of R.W. Campbell, M. Lambert, I. McTaggart-Cowan, and E. Taylor. Charles and Muriel Guiguet provided many important details.

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Harry R. Carter, National Biological Service, California Science Center, 6924 Tremont Road, Dixon, California 95620 USA.

CALL FOR PSG EXECUTIVE COUNCIL NOMINATIONS

Each year positions on the Pacific Seabird Executive Council are open for nomination of candidates. All PSG members are eligible to nominate candidates and candidates must be members of PSG in good standing (dues paid). Nominators are encouraged to determine if potential nominees are interested in serving, that they have the time and resources to devote to a position should they be elected, and that they can attend annual meetings. The following positions are open for the 2000-2001 period: Chair, Secretary, and Regional Representatives for Northern California, Hawaii and the Pacific, Old World (and most of the rest of the world), and Alaska-Russia. Nominations for a student member of the Executive Council are needed, and will appear on the election ballot, providing the proposed amendment to the PSG bylaws providing for a Student Representative is approved by the membership (SEE BELOW). Please send nominations and suggestions to Pat Baird, Nomination Committee Coordinator - see PSG Committee Coordinators list at back of this issue for contact information.

ALAN BURGER IN SEYCHELLES

If you have been trying to reach Alan Burger without success, it is no doubt related to his being in the Seychelles in the Indian Ocean. Alan, accompanied by his wife Andrea, and son for the summer, are to spend a full year working on conservation programs. Although Alan is not reachable by telephone or facsimile, he usually has access to his e-mail address, once about every two weeks.

NEW EDITOR FOR PACIFIC SEABIRDS NEEDED

The Pacific Seabird Group seeks a new Editor for Pacific Seabirds, effective with the spring issue 2000 of Pacific Seabirds. The Editor is responsible for all aspects of the editorial process from working with authors and other contributors through copy editing, layout, printing and distribution. The Editor needs to ac-

tively seek contributions for Pacific Seabirds. The Editor is assisted by associate Editors for Conservation and Technical Manuscripts, and meeting abstracts and regional reports editors. Experience with desktop publishing, and possession of appropriate software, are essential. Please contact the PSG Chair or Editor if you are interested in assuming the responsibilities of this position. A commitment of at least three years is desirable.

ENDOWMENT FUND REACHES GOAL

The Pacific Seabird Group Endowment Fund was created to support the production and printing of PSG approved publications. The amount of \$100,000 was early set as a goal for the fund to reach before interest on the fund would be available. The fund has now reached the \$100,000 goal, a result of sound investments, continued contributions, and resisting the temptation to utilize the funds. The fund trustees, Craig Harrison, Malcolm Coulter and the Treasurer, are to be congratulated for steering the fund to this point. Expenditures of interest require approval of the Publications Committee and the Executive Council. Potential authors or editors of publication projects should consider the fund as a partial source of support, to be added to outside funding. Contact the Publication Committee if you have a potential publishing project.

PSG COMMITTEE MISSION STATEMENTS NEEDED

PSG Committee Coordinators are reminded that they need to prepare a "mission statement" for their committee to be presented to the Executive Council at the next meeting in February 2000.

1999 PSG MEETING HIGHLIGHTS

The Pacific Seabird Group held its 26th Annual Meeting, 24-28 February 1999, at the Inn at Semi-Ah-Moo near Blaine, Washington. The tally of registered participants was 220, including 40 students. The scientific program began with plenary presentations by JOHN

WARHAM ("Petrel puzzles and problems") (SEE FORUM, this issue) and FRED COOKE ("Survival and fecundity of Marbled Murrelets at Desolation Sound, B.C."). Highlights of the program included two day-long symposia: "Seabird By-catch: Trends, Roadblocks and Solutions", chaired by ED MELVIN, and "Climate Variability and Seabird Response", chaired by WILLIAM SYDEMAN. Overall, there were 98 oral and 29 poster presentations. MICHAEL A. LITZOW was chosen for the "Best Student Paper" award for his oral presentation on "Consequences of variability in prey abundance and prey energy content for breeding Pigeon Guillemots". MYRA FINKELSTEIN won the "Best student Poster" award for her poster titled "Immune function as a biomarker for contaminant exposure in seabirds: development of sample storage and analysis methods". JOHN WARHAM was presented with PSG's highest honor, the Lifetime Achievement Award (SEE ABOVE), for his extensive and pioneering contributions to our understanding of petrels and other Pacific seabirds.

PSG STUDENT REPRESENTATIVE PROPOSED CHANGES TO BYLAWS

The PSG Executive Council at the 1999 meeting approved changes to the PSG Bylaws to provide for a Student Representative on the Executive Council. A ballot is enclosed with this issue of Pacific Seabirds for the membership to vote on the proposed changes. If approved by the membership a Student Representative can be voted for this fall and take a seat on the Executive Council after the 2000 annual meeting. Proposed changes and additions are shown in brackets, below.

Article III. Executive Council

Section 1. Composition. The Group shall be governed by a board of directors called the Executive Council composed of six Officers, eight Regional Representatives, the Editor of the Group's regular serial publication, [and one Student Representative].

[Section 6. Student Representative.

Clause A. Any individual who is a Student Member of the Group is eligible to run for the office of Student Representa-

tive. The Student Representative will be elected for a term of two years and is not limited to serving only a single term. If the elected Student Representative changes from student status during the term of office, the Student Representative will complete the term of office as elected.

Clause B. Duties. The Student Representative will maintain regular correspondence with Student Members and promote dialogue among Student Members. The Student Representative will act as a liaison between Student Members and the Executive Council, fostering communication and common goals for student-related issues and concerns.]

Article IV...

Section 2. Balloting. When at least one member has been nominated for a single regional seat on the Executive Council, the Coordinator of the Election committee will mail a ballot bearing the nominations to all members with residence in the area represented by the seat. Prior approval shall be obtained from said nominees. Thirty days will be allowed for the election ballots to be returned to the Coordinator of the Elections Committee, who will tabulate ballots and inform the Editor of the Group's regular serial publication and other Council members as to the results of the election. Seats representing each region will be filled by the nominees receiving the largest vote for each seat. In the event of a tie, the selection shall be made by a majority vote of the current Executive Council. Vacancies occurring on the Executive Council due to a lack of nominations shall be filled by a majority vote of the Council. Council members elected in this manner need not live in the area they represent. [Only Student Members are eligible to vote for the Student Representative. In the event of a tie, the selection will be made by a majority vote of the current Executive Council.]

EXECUTIVE COUNCIL VOTING PROCEDURES - PROPOSED BY-LAWS CHANGE

The following amendment to the Pacific Seabird Group Bylaws was approved by the Executive Council at the 1998 PSG meeting in Monterey, California and at

the 1999 meeting in Blaine, Washington. A ballot is enclosed for voting.

The Executive Council sometimes needs to vote between Annual Meetings, and a discussion ensued about alternatives to our current bylaws regarding voting procedures. PSG is registered as a non-profit group in the State of California. According to California nonprofit law, the Council can call special meetings by giving advance notice to members (4 days by mail or 48 hours by telephone), and can vote by mail or conference call. The PSG Bylaws say that notice of special meetings must be given 30 days in advance. A motion was approved to submit a Bylaws amendment to PSG members that would allow PSG to adopt California laws on notification for special meetings.

Therefore, the following Bylaws Amendment is submitted to a vote of the PSG membership:

Delete Article V, Section 1, Clause A, sentence 4 and replace it with "Notice shall be addressed to all Executive Council members in accordance with the laws of the State of California."

MANAGEMENT OF ENDOWMENT FUND - PROPOSED BYLAWS CHANGES

The following amendment to the Pacific Seabird Group Bylaws was approved by the Executive Council at the 1998 PSG meeting in Monterey, California and at the 1999 meeting in Blaine, Washington. A ballot is enclosed for voting.

The executive council approved a motion to submit an amendment to the Bylaws regarding the management of an Endowment Fund. In brief, the amendments state that the Fund shall be used to support PSG publications and will be managed by three Trustees from PSG, one of which will be the Treasurer. The Trustees will report annually to the Executive Council and actual expenditures will be by recommendation of the Publications Committee and majority vote of the Executive Council. All monies from life memberships, donations, and other sources will go to the Fund.

The following Bylaws amendment is submitted to a vote of the PSG membership:

Article VI, Section 3. Endowment Fund.

Clause A. Name and goal. The Group may maintain an Endowment Fund, the goal of which is to accumulate a core of funds. The funds shall be used to support production of the Group's publications.

Clause B. Trustees. The Endowment Fund shall be managed by three Trustees, who shall be members of the Group. The Treasurer of the Group shall be one of the Trustees. The other Trustees shall be appointed by the Chair, who should if possible select individuals with relevant investment experience. Appointed Trustees may only be removed by majority vote of the Executive Council.

Clause C. Management. The Endowment Fund shall receive monies from all Life Memberships, and from donations, bequests, and other sources as determined by majority vote of the Executive Council. The Endowment Fund shall be invested as determined by unanimous agreement of the Trustees. If the Trustees cannot decide on management of the Fund, the Executive Council shall do so by majority vote.

Clause D. Expenditures. The Trustees shall report annually to the Executive Council on the funds available for expenditure. In determining the availability of funds, the Trustees shall manage the Endowment Fund to protect the principal of the Endowment Fund over time. The actual expenditure of funds shall be recommended by the Publications Committee and decided by majority vote of the Executive Council.

Clause E. Purpose of Expenditures. Funds determined by the Endowment Fund Trustees to be available for expenditure may only be used for the production of Pacific Seabird Group publications."

PSG WEB SITE SEABIRD GALLERY NEEDS CONTRIBUTIONS

Images of seabirds of the world are needed for the PSG Seabird Gallery on the PSG web site. Images of birds flying, on the water, on nests, all age classes, colonies, and nest sites are needed. Sound recordings can be incorporate. Check out the site - contributions are needed.

REPORT OF THE SECRETARY

SUMMARY OF PROPOSED MINUTES OF THE 1999 PACIFIC SEABIRD GROUP EXECUTIVE COUNCIL MEETING

Semi-ah-moo Resort, Blaine, Washington, 24 and 27 February, 1999

By *Kathy Kuletz, Secretary*

(Note: The full text of the Proposed minutes is available from the Secretary, Kathy Kuletz [kathy_kuletz@fws.gov]. The minutes will become official when they are approved by the 2000 Executive Council meeting).

The council met on 24 and 27 February 1999 at the Semi-ah-moo Inn in Blaine, Washington. Both meetings were called to order by Chair Alan Burger. Present at the first meeting were Jan Hodder, Ed Murphy, Tony Gaston, Rob Suryan, Pat Baird, Beth Flint, Jim Lovvorn, Pat Mock, Kim Nelson, Kathy Kuletz, Vivian Mendenhall, Bill Sydeman, Craig Harrison. Attending ex-officio were Ken Warheit, Julia Parrish, Scott Hatch, Charla Sterne. Proxies were held by Hodder for Roy Lowe, Burger for Mark Tasker, and Harrison for Steve Speich. The second meeting was attended by Murphy, Gaston, Baird, Suryan, Nelson, Flint, Mock, Hodder (also proxy for Jim Lovvorn), Burger (also proxy for Mark Tasker), Harrison (also proxy for Steve Speich), Kuletz and Dave Duffy. The minutes of the January 1998 meeting were approved. Reports of Officers were provided to the Chair and are available in Pacific Seabirds (PS). Alan thanked Steve Speich for his good work on the Web page and investigation into electronic journals.

OLD BUSINESS

REPORTS OF OFFICERS AND COMMITTEES

FINANCIAL MATTERS

Report from the Treasurer: J. Hodder reports that PSG's financial status is good and we have about \$27,000 for operating costs. We dipped into reserves to support the PSG meeting, but this is typical and will be repaid after the meeting's expenses. Annual operating costs for PSG run about \$11,000. The new treasurer (Breck Tyler) will be brought up

to speed with the accounting program. The **Endowment Fund** is currently at about \$90,000. Harrison, Hodder and Malcolm Coulter will plan what to do when we reach the goal of \$100,000. Before passing the budget, an amendment was passed to allocate \$750 to help fund transportation costs for the guest speaker.

There was discussion about the need for a discretionary fund to help with costs of speakers and people receiving awards. Currently, extra funds come from individual contributions. It was suggested that if more members knew about the need for extra funds, fewer individuals would have to foot the bill. A contribution request could be included on ballots or membership forms.

PUBLICATION COMMITTEE

EVOS Restoration Report. - K. Warheit discussed the possibility of resurrecting the EVOS Restoration project. There is a need for a scholarly reference that can be used in current and future oil spills. The current Technical Publication would form the foundation, with each chapter filled out by selected authors. Money could be used for author stipends and page charges. The money (\$15,000 from EVOS Trustee Council) is not enough to complete the task. George Divoky and K. Warheit are open to help and suggestions. They will provide a detailed proposal and line up a publisher. K. Warheit points out that requests for the Technical Publication (\$18) be forwarded to the Secretary.

The **Seaduck Symposium** will be published soon, at no additional cost to PSG. The **Bycatch Symposium** will be covered by money arranged by Ed Melvin. The **Proceedings of the 25th Anniversary Symposium** are being reworked due to delays in obtaining finished chapters and securing a publisher. Only 7 of 17 chapters are written, and those were written for a book. To publish in *Studies in Avian Biology* would require

rewriting the completed chapters. A. Burger and D. Duffy recommend changing some authors, redefining two chapters, and going with the Smithsonian. There is no need to vote on funding yet. Duffy will report back later about other options.

The "**Seabirds of the Russian Far East**" is being published with funds from Canadian Wildlife Service (CWS). There should be some profit, so PSG will recover costs and extra profits will go to CWS. We authorized the publication committee to enter an agreement with CWS for its publication.

Web Site: We discussed concerns about offering PSG abstracts on the web site. Some members wondered whether people would tend not to join PSG if they can obtain the abstracts from the meetings off the web. The general consensus is that access to abstracts is not a major reason people join PSG, and so it should not be an issue.

OTHER COMMITTEES

Sunset Law for Committees - As M. Tasker did not provide a draft Sunset rule, a motion was approved to move on this issue at this meeting. P. Baird and K. Nelson presented a draft plan for determining if a committee should continue. They provided a list of actions, contacts, and chain of inquiries. Baird offered to draft the guidelines for publication in the next PS. There is no need for a bylaw amendment.

Elections- P. Baird reports there were only 40 responses to the last ballot. To ensure best coverage and wider selection, it is recommended that the Secretary announce requests for call for nominations in Pacific Seabirds. Regional representatives should enlist others to run in their regions. Part of Regional Representative's job should be to enlist >2 people to replace them.

REPORT OF THE SECRETARY

Awards Committee- K. Nelson would like to standardize awards and present certificates to some past recipients which were never properly acknowledged. There is also a need to standardize lifetime achievement nominations, which are currently informal. Nelson recommends that PSG produce a list of potential candidates for later circulation and consideration. Any members that would like to add names to this list are encouraged to send nominations to A. Burger.

Restoration committee: B. Sydeman reports that the Tenyo Maru Restoration plans have been finalized and written up. Dave Ainley will be taking over as coordinator of Restoration Committee. Because Dave will be gone 2-3 months per year, Mike Parker will fill in as needed. There was discussion whether PSG needs to respond on an annual basis to long-term oil spill programs. The Chair is designated to draft or sign PSG comments on restoration plans.

Seabird Monitoring committee- S. Hatch reports significant progress this year, with the database (pulled together by Charla Sterne) about 80% completed. The database is on CD and was distributed for comments among PSG members and other contributors. So far, they haven't had much feedback. Data entry and retrieval are the main issues of interest. The database has 12,000 observations of 1900 time series for many seabird parameters. One possible avenue for eventual distribution is the internet. Hatch suggests that Stern be kept on as database manager.

There followed a discussion about the tracking of large contracts like this. PSG charged a 5% administrative fee, which would likely not cover the accounting fees of an audit. After discussion, a motion to charge a minimum 10% in future contracts failed to pass. The consensus was that contracts vary and administrative costs should be determined by project.

Japanese Seabird Conservation Committee (K. Nelson) published their report in PS. They suggest changing the committee name to 'Far East Seabird Conservation Committee', since they are now dealing with more than just Japanese seabirds. **Marbled Murrelet Technical Committee** (K. Nelson for T. Hamer) has the report in PS. The inland protocol should be done by next fall, following final analyses. The new coordinator for

the inland protocol is Diane Evans. **Xantus' Murrelet Committee** (A. Burger for B. Everett) opened discussion about the move to continue or disband this committee. Several members want this committee to continue. Others think that existing committees (ie., Conservation) should be able to form a 'task force' for individual species that lasts 1-2 years. Currently, the mandate is to decide whether to list Xantus'. Others want to do more, as there are conservation issues related to this species. These issues will be taken up later by interested members.

Conservation Committee. - C. Harrison did a lot of miscellaneous correspondence on variety of issues. The biggest issue was the Caspian tern colony on Rice Island, Columbia River, which the Army Corp of Engineers wants to destroy; the outcome has been disappointing. He dealt with Alaska longline regulations and gillnet issues of Canada and U.S. There are no longline regulations in Hawaii yet, but they may be moving toward proposing rules. Details are in the Conservation Committee report. Harrison is on the board of the American Bird Conservancy and 2nd delegate for the Ornithological Council. Because PSG joined IUCN, we're now an international NGO, which will allow us to get involved with international issues and have more impact. We could add these umbrella organization logos to our letterhead and web site, to emphasize our international focus.

OSNA - The EXCO was disappointed by the recent rejection of our application to join the Ornithological Society of North America (OSNA). A. Burger will write a letter to OSNA to suggest they reconsider us when their internal problems are settled.

North American Waterfowl Conservation Plan. - J. Lovvorn reported on his work with the NAWC plan. There is no consensus on what input PSG should have regarding this plan. So far we have been on the fringes of its development.

NEW BUSINESS

Annual meetings- K. Nelson has a list of 4 local committees that would host meetings. Only the first (San Francisco Bay area in 2000) is definite. There was concern about the cost of rooms in the Bay area (being researched by Ken Briggs) and exactly what site to use next

year. K. Briggs will expand his search area and find a better deal. Beth Flint is on the Hawaii local committee for 2001. They're most interested in Kauai (better for seabirds).

We discussed student support. Endowment Awards could go towards supporting some students. There is discussion about whether it should be ad hoc or a continual, well defined process. Perhaps this could be a job for the student representative. Some members note that we already give student discounts for PSG meetings, in registration and rooms. There have been requests for student support for travel to meetings. This would be costly and exclusive, since at most we could only provide for one or two students.

There were questions about latitude for local committee regarding vendors at meetings. Harrison points out that the rules are already in the Handbook. These types of decisions should be left up to local committees. Examples of what's been done will be included in the Handbook.

The length of presentations and concurrent sessions is still problematic. It is suggested that 20 min. papers, with fewer papers and more posters, is more desirable than 10 min. papers and concurrent sessions. Many papers are annual reports of on-going projects. Its agreed that the Chair Elect should send out notice recommending posters for updating ongoing projects. New studies and those being wrapped up would get first consideration for oral presentations. J. Parrish will draft a notice for the Handbook regarding rules for papers and K. Nelson will draft a memo for PS to encourage limited oral presentations.

Bylaws -The last update of bylaws was in 1994. The Secretary needs to update the bylaws, which is also necessary for taxes. K. Kuletz will see that the newly passed bylaw amendments are sent to the members for a vote of approval.

PSG Handbook - K. Nelson has updated a new draft of a PSG operational handbook and will be soliciting reviews. She will continue this project after she leaves the EXCO.

North American Bird Banding Council. - K. Nelson went to the NABC meeting last year. Last year we voted to not join NABC, but they ask that we re-

consider. Most other bird groups in N. America have already joined. Cost is about \$200. We would be asked to develop the manual and standards for seabird banding. These may influence or be used by government agencies to develop regulations, so members will be involved anyway, and we may as well be involved officially. A motion was passed to join the NABC. There was discussion about who would go to the meetings as PSG representative, and what that would cost. The delegate should be a contact point between us and NABC.

Student representation - We discuss the idea of a student representative on the EXCO. Giving students full participation will expose them to financial problems and decisions that EXCO deals with. Few members sit in on EXCO meetings anymore, and maybe a student rep would encourage greater participation. A motion was passed to establish a student representative on the executive council, to be elected by students, as a full voting member. As this may require a bylaws amendment, E. Murphy and J. Parrish will look into the need to change bylaws.

Voting by email. - Discussion about whether we should allow voting by email. It is a standard form used by other groups. We would need to change bylaws. No motion is made, and the bylaws stay as is.

Electronic Journal. - Alan summarized the options and opened the discussion about an electronic journal. The first issue is whether we should take over the journal 'Marine Ornithology'. John Cooper is the founder and will meet with us later at the meeting. The advantage is that it is an existing journal with an experienced board and has a following. Currently it deals more with the southern hemisphere. A disadvantage is that it is about 4 years behind in publishing. The electronic journal will need a good editorial support system and a professional web site person.

After meeting with Cooper, we discussed the need to develop a prospectus and business plan for the electronic journal. J. Parrish, T. Gaston, and P. Mock will draft a business plan working closely with Steve Speich (as managing editor/web distribution). T. Gaston is willing to be scientific editor, depending on time allotted from his job. Part of the prospectus would be coming up with a new edi-

tor. Another part is to connect with other seabird groups, (ie., Southern Hemisphere). A. Burger will work with John Warham to connect with New Zealand/Australia etc. Other bird groups may at least want to add our option to their web page, even if they don't want the journal. A motion is passed to allocate \$500 to Speich to develop the technical aspect of the journal.

April EXCO meeting. - Several issues related to the journal will need to be decided on by April. The EXCO agrees to meet by phone in early April to vote about the electronic journal and bylaw changes to allow a student representative. The business plan and prospectus should be sent out by March 20 to allow others to review options before the meeting.

Rules for use of membership list. - There was a motion a few years ago that we charge \$50 for use of our list. There are concerns about handing out the list. If it's the publisher of a book, they can advertise in PS. A motion was passed that PSG as a general rule doesn't sell or give the membership list to commercial organizations or individuals, and that the use of the membership list by nonprofit organizations or individuals should be at the discretion of the Chair after consultation with the executive council.

Committee Mandates. - K. Nelson still doesn't have committee mandates from everyone. A. Burger recommends that Nelson put the mandates in the PS. There is discussion about whether we need to edit and vote on them first. Its decided to put the mandates in PS next year, then ask for comments. K. Nelson will get them in to PS for publication.

PSG Archives. - Archiving PSG items is an ongoing problem. We have no permanent place to keep everything and often resolutions are passed and then forgotten. Vivian Mendenhall published them in 1995 in PS, but they need to be updated and in one document. The Secretary should consolidate all resolutions and any legal documents related to PSG. Everyone should send their important records to the Secretary or Treasurer (for financial items). Email records are another issue, and the secretary is backing up important email. It would be useful to have electronic copies of email correspondence, particularly for the Treasurer, and backup copies.

Vision Working Group. - T. Gaston published the results of the Vision Meeting and his proposed Conservation Appraisal Plan (CAS) in PS. We discussed CAS at the April 1998 Vision meeting (attended by Burger, Kuletz, Gaston, Parrish). The plan is to submit the CAS proposal for a Packard Grant. Nothing is resolved in terms of money and time commitment for PSG. The recommendations from the vision meeting were extensive and involved a move toward more proactive conservation. Parrish and Gaston will put out a survey that will ask about the status of seabirds outside North America. They will collate and publish it in PS. We should initiate the survey now to prepare for a new grant. The \$100,000 grant would begin only the first phase. The project would require a permanent home for the program and PSG administrative responsibilities. A. Burger is still working with J. Parrish on a new Packard Grant.

Discussion centered on the effort the CAS will require, especially in the same year we try to launch a journal. There is not enough information now to decide to omit or delay either the journal or Packard grant. A consensus will be drawn after the early April meeting. Parrish and Gaston will move ahead as planned with the questionnaire. It is recognized that even if we can't implement the plan, PSG will have provided a worthwhile service in devising the plan.

Member Sponsorship. - R. Suryan was asked to bring up the issue of sponsoring people in other countries for membership. PSG is already doing this for several people in undeveloped countries. Another option is for a member to pay the dues for someone they want to sponsor. We usually request the sponsored member write something in PS to keep PSG updated on their region. Currently this relies on Malcolm Coulter to contact others. Maybe we need some mechanism to allow people to solicit PSG for sponsorship. Suryan will contact Malcolm about the process. It is suggested that PS have a piece to encourage members to contribute or sponsor someone. Perhaps the Treasurer could ask for contributions to support potential members in underdeveloped countries (i.e., in dues notice). The meeting adjourns with the motion to thank retiring members (Tony, Pat, Jan, Kim) for all their good work, and the local committee for a great site and meeting.

ABSTRACTS

ABSTRACTS OF PAPERS AND POSTERS PRESENTED AT THE 26TH ANNUAL PSG MEETING The Inn at Semi-Ah-Moo, near Blaine, Washington, 24- 28 February 1999

Prepared by *Danielle Prenzlow Escene*

Papers are arranged by sections, corresponding to the session of presentation: Plenary Presentation, Climate Variability Symposium, Seabird By-Catch Symposium, and general Oral and Poster Presentations. Papers are arranged alphabetically by first author name within each section.

PLENARY PRESENTATION

PETREL PUZZLES AND PROBLEMS

John Warham. University of Canterbury, Christchurch, NEW ZEALAND.

I will discuss a range of difficulties and unknowns — anatomical, behavioural, and physiological — regarding tubenoses, e.g. the roles of olfaction, capture of birds using vocal and other lures, census methods, sound production, birds in deep burrows, and DNA taxonomy.

SURVIVAL AND FECUNDITY OF MARBLED MURRELETS AT DESOLATION SOUND, B.C.

Fred Cooke^{*1,2}, *Lynn W. Loughheed*^{1,2}, *Gary Kaiser*², and *Sean Boyd*².
¹CWS/NSERC Chair of Wildlife Ecology,

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A marked population of Marbled Murrelets (*Brachyramphus marmoratus*) has been studied in considerable detail since 1991 at Desolation Sound, British Columbia. During that time 1,154 birds have been caught using either a mist-netting or dip-netting technique and more than 100 birds have been recaptured at least once, with a recapture rate of 12.5%. Using CMR methodology on these data, we update our estimation of local annual adult survival of this population to the value of 0.848 (0.604 - 0.953) using the program MARK. This is close to the value pre-

dicted by Beissinger (1995) assuming an allometric relationship between survival and body size in alcids. Forty adult murrelets had radio transmitters applied to them in May and their subsequent movements noted for nesting activity. Ten of these did not nest, but 24 were followed to nests and 23 nests were found. Five nests that were active in late chick rearing were climbed, and three of these fledged chicks. Breeding success of this sample, the largest sample of active nests ever discovered in a single season in this species, was estimated at around 39%, with an overall fecundity (including the non-breeders) of 29%. There are however large error estimates in these values and larger samples are needed. Nevertheless these estimates provide initial data on which to begin population modeling.

CLIMATE VARIABILITY SYMPOSIUM

EL NIÑO 1997-98: SEABIRD RESPONSES FROM THE SOUTHERN CALIFORNIA CURRENT AND GULF OF CALIFORNIA

Daniel Anderson^{*1}, *James Keith*², *Eduardo Palacios*¹, *Enriqueta Velarde*³, *Franklin Gress*¹, and *Kirke A. King*⁴.
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El Niño 1997-98 caused significant effects on breeding and wintering seabirds of Baja California and Southern California. In 1998, there were about 1200 BRPE

nest attempts in the Midriff of the Gulf of California compared to a long-term average of about 25,000 nests (<5% of normal); one nest produced young. BRCO, DCCO, and YFGU followed the same trends, but some did produce a few young (<5% of normal). BRPE and BRCO effort and productivity improved north from Baja California into California and in the La Paz area, but was still highly variable (<1% to <90% of normal). In the Southern California Bight (SCB), BRPE nesting effort in 1998 was <47% of 1997, but productivity (associated with chick mortality) in 1997 (as ENSO conditions set in) was 0.3 YY/N, compared to 0.9 in 1998 (as ENSO subsided). Depressed nesting effort in the Gulf of California also occurred in BRBO, BFBO, LESP, BLSP, ELTE, ROTE, and HEEG; off western Baja California in ROTE, DCCO, and CATE; and in the SCB, also in BRCO

and DCCO. At Rasa Island (where >95% of the species nests), numbers of territorial HEEG were not reduced, but the proportion of these potential breeders that laid eggs was reduced. Productivity was 0.01 YY/N compared to 0.47 in 6 previous, non-ENSO years. ELTE nesting in 1998 consisted of 180 nests compared to about 40,000 averaged over 9 previous years; but those few ELTE reproduced normally. YFGU were more dispersed and pelagic than expected and storm-petrels occurred at sea in much lower abundances than during non-ENSO periods. Resident seabirds such as BRPE and boobies also suffered elevated mortality in winter 1997-98; but mortality was much more pronounced in wintering species such as grebes and loons, and it extended into June 1998. Dying EAGR in the Gulf of California and off the Baja California west coast were emaciated. OSPR, a resi-

ABSTRACTS

dent feeding on resident fish, was more successful; yet, still only about 1/2 of the original OSPR nesting attempts in Bahia de los Angeles were still occupied by May 1998, producing only 0.3 fledglings per nest attempt, the lowest level yet recorded. Overall, 1997-98 was the most extensive El Niño-related nesting failure in Baja California seabirds in 30+ years of detailed study.

ANOMALOUS WEATHER EVENTS IN THE SOUTHEASTERN BERING SEA: THE CONDITION OF SHORT-TAILED SHEARWATERS IN 1997 AND 1998

Cheryl L. Baduini^{*1}, K. D. Hyrenbach², and G. L. Hunt, Jr.¹ ¹Dept. of Ecology and Evolutionary Biology, University of California at Irvine, Irvine, CA 92697, USA, cbaduini@uci.edu, glhunt@uci.edu; ²Scripps Institution of Oceanography, University of California at San Diego, La Jolla, CA 92093, USA, khyrenba@ucsd.edu

Both 1997 and 1998 were marked by unusual weather conditions in the southeastern Bering Sea, however the patterns were strikingly different. In 1997, a high pressure anomaly occurred over the Bering Sea and resulted in low winds and few severe storms in June and July, an unusually warm mixed-layer in summer, and depletion of macronutrients to greater than 60-m depth. In 1998, a low pressure anomaly occurred over the same area which resulted in frequent spring storm events that lasted into late June, a delayed set-up of thermal stratification, and prolonged production in the water column. Lack of mixing, higher sea surface temperatures, and early cessation of production in 1997 may have contributed to the lack of available euphausiid prey to short-tailed shearwaters (*Puffinus tenuirostris*). The result was that hundreds of thousands of short-tailed shearwaters died in August and September 1997, apparently of starvation. In 1998, we observed lower overall body condition of short-tailed shearwaters compared to 1997, yet no large scale mortality event occurred. When adjusted for overall body size, net body mass, lipid mass, and pectoralis mass was lower in June 1998 than June 1997. Also, these measures were lower for shearwaters in the Bering Sea in September 1998 compared to September 1997. Between 1997 and 1998, we also observed a shift in the diet of shearwaters from primarily euphausiids, *Thysanoessa*

spp., in September 1997, to fish, specifically, sand lance and age-0 pollock, in September 1998. We hypothesize that the availability of these alternative food sources in 1998 may have prevented the occurrence of another large scale mortality event.

OCEAN CLIMATE CHANGES MISMATCH PREY AND BREEDING SEABIRD POPULATIONS

D. F. Bertram^{1,2}. ¹Wildlife Ecology Research Group, Simon Fraser University, Burnaby, British Columbia, V5A 1S6, CANADA; ²Canadian Wildlife Service, Delta, British Columbia, V4K 3N2, CANADA, dbertram@sfu.ca

Climate change has been linked to the advancement of warm temperatures in the spring. Here I report significantly earlier breeding of seabirds on the largest colony in Western Canada, Triangle Island from 1975-1998. The rate of timing advancement as gauged by hatch date is on the order of 1 d per year for Cassin's Auklet, Rhinoceros Auklet, and Tufted Puffin, but is close to 2 d per year for the Common Murre. Concurrently, the timing of the peak availability of the copepod *Neocalanus plumchrus* (the dominant form of zooplankton biomass for the subarctic North East Pacific) has advanced by almost 2 d per year since 1975. I propose that differences in the rates of seasonal advancement for seabird timing and zooplankton availability has created a mismatch in the timing of prey and predator populations. Moreover, this mismatch has likely contributed to an increase in the incidence of reproductive failure for the Cassin's Auklet, Rhinoceros Auklet and Tufted Puffin in recent years.

EFFECTS OF THE 1997-1998 EL NIÑO ON SEABIRDS BREEDING IN BRITISH COLUMBIA

D. F. Bertram^{*1,2}, A. Harfenist², A. J. Gaston³, and T. Golumbia⁴. ¹Wildlife Ecology Research Group, Simon Fraser University, Burnaby, British Columbia, V5A 1S6, CANADA, dbertram@sfu.ca; ²Canadian Wildlife Service, Delta, British Columbia, V4K 3N2, CANADA; ³CWS, Hull, Quebec, K1A 0H3, CANADA; ⁴Parks, Canada, Box 37, Queen Charlotte City, British Columbia, V0T 1S0, CANADA.

British Columbia has a diverse range of

alcids breeding in three distinct oceanographic domains. We examined the breeding chronology, breeding propensity and productivity on five colonies in British Columbia where time series of at least three consecutive years were available. Numbers of breeding Cassin's Auklet on Triangle and Frederick Island were significantly reduced and timing was delayed. Nestling growth and breeding success was reduced on Triangle Island but not on Frederick Island. Breeding of Ancient Murrelets on Limestone Island began early, but was spread over a much longer period than usual. In addition, half of the burrows were deserted during incubation, far more than has been observed in previous years. The patterns of intercolony variation for timing of breeding and nestling growth were similar to previous years for Rhinoceros Auklets nesting on Triangle Island, Seabird Rocks and Sgan Gwaii. Tufted Puffins on Triangle Island commenced breeding significantly earlier than in any previous years but experienced reproductive failure similar to other recent years. The Common Murres on Triangle Island had similar timing of breeding and strong reproductive performance as in previous years in the 1990s. We will highlight the interspecific similarities and differences in the observed patterns of breeding and examine the short term variability in the context of large scale interdecadal oceanographic changes.

THE IMPACTS OF THE 1998 EL NIÑO-SOUTHERN OSCILLATION ON NEARSHORE COMMON MURRE COLONIES IN CENTRAL CALIFORNIA

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El Niño-Southern Oscillation (ENSO) events have been shown to have serious negative impacts to the breeding success of Common Murre colonies. The near-

shore Common Murre colonies at Devil's Slide Rock, the Point Reyes Headlands, and Castle and Hurricane Point Rocks were variously affected by the 1998 ENSO event this year. These impacts ranged from irregular attendance, delayed onset of breeding, decreased number of breeding pairs, increased disturbance by California Sea Lions and increased predation. These events had differing impacts on the reproductive success of our monitored colonies. This is the first year that detailed impacts of an ENSO event was documented on these nearshore colonies. Our monitoring efforts revealed many insights into how the ENSO impacts nearshore colonies and our active restoration site at Devil's Slide Rock.

RESPONSES BY MARBLED MURRELETS, INLAND AND AT SEA, TO VARIATIONS IN NEARSHORE OCEAN TEMPERATURE IN BRITISH COLUMBIA

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Periodic warm-ocean episodes are known to have negative impacts on some seabirds in the Pacific Northwest. Effects on the threatened Marbled Murrelet are not known. I review the responses of the murrelet to variable nearshore temperatures for 1979 through 1998, which includes two strong ENSO events and a general warming trend. Data from systematic marine transects were available from seven sites in B.C., covering 4-8 years per site. There was considerable intra- and inter-seasonal variation in the densities of murrelets in these samples, with weak negative effects of warm seas at some sites. Surveys of murrelets at inland breeding habitats in the old-growth forests of Vancouver Island over 8 years showed significant effects of ocean temperature. Specifically, the mean frequency of occupied detections, a measure of nearest flight behaviours, was strongly negatively correlated with nearshore ocean temperature. Although the link between occupied detections and nesting success is not clear, these results suggest that warm nearshore conditions inhibit breeding activity to some degree. Reduced prey availability in warm seas is a likely cause. This has important implications for conservation and monitoring of this species. Inland surveys of flight detections are

often used to delineate and map suitable habitat for murrelets as part of logging plans, and could be seriously flawed if they sampled years with depressed activity. If murrelet breeding is inhibited by warm oceans then global warming, coupled with continued loss of nesting habitat in old-growth forests, is likely to lead to significant population declines.

POSSIBLE EFFECTS OF EL NIÑO ON BREEDING SEABIRDS IN ALASKA IN 1998

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Reproductive failures of seabirds, presumably due to shifts in prey distribution, have been documented during periods of unusually warm sea temperatures associated with El Niño Southern Oscillations. The most recent El Niño event in 1997 and 1998 was one of the largest recorded, and we were interested in trying to determine whether breeding seabirds in Alaska demonstrated a response. We examined selected parameters of breeding success for common species including: black-legged kittiwakes (*Rissa tridactyla*), murres (*Uria* spp.), rhinoceros auklets (*Cerorhinca monocerata*), and tufted puffins (*Fratercula cirrhata*) at breeding colonies throughout the state. The most obvious anomaly was that murres had below-average productivity in the western Gulf of Alaska and southeastern Bering Sea regions. We discuss this outcome, which was surprising because no such effect was seen for kittiwakes, frequently more sensitive to environmental perturbations than murres, at some of the colonies where murres failed. Furthermore, murres did not fail in southeastern Alaska or in some of the colonies in the central Gulf of Alaska, "upstream" of the colonies where low success was recorded.

CLIMATE CHANGE IN THE WESTERN ARCTIC SINCE THE "LITTLE ICE AGE" — EFFECTS ON PACIFIC SEABIRDS

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Since the end of the "Little Ice Age" in the last century, the earth has experienced a period of increasing atmospheric temperatures. Polar regions are the first to demonstrate the effects of global warming due to patterns of atmospheric circulation and the presence of snow and ice habitats that respond immediately to alterations in temperature. In the northern Pacific and adjacent Arctic Ocean large numbers of seabirds breed in regions where seasonal snow restricts access to nest sites and sea ice limits access to prey in the water column. Significant changes in the duration of seasonal snow and ice cover with increasing air temperature should reduce temporal restraints on breeding and migration and, theoretically, allow for population and range expansion.

Evidence for such changes comes primarily from northern Alaska and the adjacent Arctic Ocean. The snow-free period in northern Alaska has increased by >4 days per decade over the last 50 years allowing population expansion and increases for at least two alcid species. Predictably, subarctic populations are demonstrating few effects of changes in snow and ice cover. Any benefits that seabird populations experience from the reduction in the physical constraints of ice and snow may be reduced or negated by climate-driven oceanographic changes reducing prey abundance or availability.

OSCILLATIONS IN THE NORTH ATLANTIC AND SOUTHERN HEMISPHERE: GULF STREAM LAGS AND PETREL PILE-UPS

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In response to steep pressure gradients across the North Atlantic and Southern Pacific Oceans (high values of the NAO and ENSO indices, respectively), the mean position of the Gulf Stream current shifts northward after a two-year lag. This northward movement of the Gulf Stream displaces storm tracks over the Northwest Atlantic, and broadly influences weather patterns over Western Europe. Although the resulting effects have been hard to detect in local meteorological observations, linkages between the northward movement of the Gulf Stream and the incidence of several biological phenomena (changes in marine zooplankton abundance, vegetation dynamics, etc.) are firmly established. So far, no reports have

related extremes in the NAO and ENSO (and the lagging northward movement of the Gulf Stream) to changes in the distribution, abundance, or demography of North Atlantic seabirds. Black-capped Petrels are closely tied to the Gulf Stream; they track its onshore and offshore movements and accumulate along the troughs of meanders. Since the oceanographic bases for these associations are understood, the consequences of northward movement of the Gulf Stream on the distributions of Black-capped Petrels can be predicted and then related to broader-scale forces, the NAO and ENSO. During the course of my pelagic surveys off North Carolina (1992-96), the annual abundance of Black-capped Petrels was markedly elevated in only one year — the only year in which the NAO-lagged index was low (0.0) and conditions favoring upwelling at Cape Hatteras were enhanced.

RESPONSE OF SEABIRD ABUNDANCE TO LONG-TERM CHANGES IN THE CALIFORNIA CURRENT, 1987-98

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Seabird communities off southern California have undergone gradual and persistent changes (Veit et al. 1996) in response to long-term ocean warming and declining zooplankton biomass since the 1950's (Roemmich and McGowan 1995). In a previous study, Veit and coworkers (1996) reported that overall seabird abundance off southern California had decreased by 40% between 1987-1994, mostly due to the 90% decline in the dominant cold-water species, the sooty shearwater (*Puffinus griseus*).

Here, we provide evidence of subsequent changes in seabird abundance off southern California during 1994-98, a period of continued decreases in zooplankton biomass. Since 1994, total seabird abundance and sooty shearwater numbers have remained consistently lower than during 1987-94, suggesting that the long-term decline off Southern California continues.

In addition to long-term (decadal)

trends, short-term (interannual) changes in ocean conditions are known to affect seabird distribution and abundance off southern California (Ainley 1976, Ainley et al. 1995, Veit et al. 1996). Despite evidence of transient changes in seabird abundance related to warming (e.g. 1997-98 El Niño) and cooling (e.g. incoming 1998-99 La Niña) episodes during 1994-98, the available data suggest that the long-term association between seabirds and oceanographic variability overrides the less persistent short-term trends.

CLIMATE IMPACTS ON MARINE ECOSYSTEMS: EL NIÑO, PDO AND IMPLICATIONS OF CLIMATE CHANGE

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Climate-induced changes in marine ecosystems trigger a cascade of ecological impacts throughout the marine food-web. Such impacts are often most visible (to humans) in their impacts on higher-order predators like sea birds, marine mammals, and commercially popular fish stocks. The effects of anthropogenic climate change (greenhouse warming) on marine ecosystems will most likely occur via multi-scale atmosphere/ocean circulation changes, and not simply by direct (radiatively driven) heating of the oceans.

From the perspective of marine ecosystems, Pacific interdecadal climate shifts between warm and cold phases (Pacific Decadal Oscillation) have been linked to decade-to-decade changes in Pacific salmon production from western Alaska all the way to central California. In addition, shorter-lived El Niño-related changes to the marine environment have caused temperature and spatial displacements of many open-ocean bird and fish species, as well as important changes in overall ecosystem productivity. Common to both El Niño- and PDO-related marine climate fluctuations are regionally specific swings in primary and secondary productivity (via phyto- and zooplankton production, respectively) that trigger a cascade of ecological impacts throughout the marine food web.

Generally speaking, processes important to marine ecosystems take place at regional and smaller scales. Global-scale climate models now used to investigate the impacts of increased concentrations of

greenhouse gases globally, are not yet as useful at these regional and smaller scales.

Based upon observed climate impacts on marine ecosystems, the following impacts are likely to occur as a response to future anthropogenic climate change: 1) species distributions will change; 2) there will be winners and losers; for example, warm phases of the PDO correspond to high productivity in the Gulf of Alaska and low productivity in the California Current (vice-versa with the cold phase of the PDO); 3) ecosystem surprises are to be expected; and 4) if present day El Niño and PDO-like warm episodes are a model for future climate changes, warm water pelagic fish (e.g., albacore, mackerel, sardines) will become more common in nearshore and higher latitude waters of the northeastern Pacific.

TIME FLIES: BIOPHYSICAL INTERACTIONS INVOLVING SEABIRDS IN THE NW ATLANTIC

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Changes in seabird populations, breeding success and diets are robustly associated with oceanographic changes and perturbations over multiple temporal scales in the NW Atlantic. Growth of the breeding population of gannets is closely associated with centennial warming of surface waters and the concurrent movement of warm-water migratory pelagic mackerel and squid into the region. Cold surface water events in the 1990s had profound effects on breeding success of surface-feeding seabirds but less influence on pursuit-divers. These effects were amplified by the Eastern Canadian Ground Fish Moratorium which eliminated massive tonnages of fishery discards and offal from the NW Atlantic and had profound consequences for scavenging and predatory gulls. Deprived of fishery discards and offal, gulls were further food-stressed by cold-water induced delays of the in-shore movements of capelin, the primary forage fish of the NW Atlantic vertebrate food web. Consequently, gulls intensified predation pressure on kittiwakes and puffins, with the former being both food- and predator-stressed. The gulls' breeding success has been poor and indications are that populations are decreasing. Changes in seabird diets in the 1990s provided

initial indications of cold-water induced shifts in pelagic food webs over the Newfoundland Shelf. Oceanographic changes and perturbations appear to influence the migratory and vertical movements of pelagic and forage fishes and invertebrates, indirectly affecting seabirds in the process, and changes in seabird ecology associated with oceanographic influences are exacerbated by fisheries activities. Clearly, basic understanding in marine ecology, as well as management strategies involving marine resources, must integrate biophysical interactions.

RESPONSE OF SEABIRDS TO CHANGES IN THE CALIFORNIA CURRENT, 1985-1997

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Since the early 1950s, the California Current has exhibited a long-term increase in sea-surface temperature and greater stratification of the upper water column. In turn, the upwelling of deep, nutrient rich water has lessened with a concomitant decrease in primary production and macrozooplankton biomass (e.g. McGown et al. 1996). In response, overall abundances of seabirds, at the top of trophic levels, have declined by 40%, mainly due to the 90% decrease in the numerically dominant Sooty Shearwater (e.g. Veit et al. 1997).

We present information on seabird abundances in waters off central California collected on annual cruises, 1985-1997. The abundance and distribution patterns exhibited, in response to the changed ocean conditions, differed by species, as exemplified by the three most abundant species, Sooty Shearwater, Common Murre and Cassin's Auklet. Responses were related to differing life histories, morphologies and feeding habits. The shearwater moved out of the system, the murre moved inshore, and the auklet — the only true zooplanktivore — showed a crash in population size.

SEABIRD AND MARINE ECOSYSTEM RESPONSE TO CLIMATE VARIABILITY IN ALASKA

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Marine climate in the NE Pacific fluctuates at four dominant time scales: 2-3 years (Quasi-Biennial Oscillation, QBO), 5-7 years (El Niño-Southern Oscillation, ENSO), 20-25 years (Bi-decadal oscillation, BDO), and 50-75 years (very low frequency oscillation, VLFO). Since the 1850's, marine climate has flip-flopped 13 times between "cool" and "warm" states. The duration and magnitude of these states depend on whether oscillations are in phase or not. Both QBO and ENSO effects are evident on seabirds in Alaska, but effects are transient, localized, and appear to have little long-term effect on seabird populations and marine ecosystems. VLFO effects cannot be evaluated from existing data, except to the extent that when VLFO oscillations are in phase with BDO oscillations, they have more impact on marine climate and ecosystem structure. Decadal oscillations have the greatest measurable impact on seabird populations; mediated through persistent effects on food supplies. Cold regimes favor a variety of important forage taxa (e.g., shrimp, capelin, herring, Atka mackerel) while warm regimes favor large predatory fish (arrowtooth flounder, halibut, pollock, cod, salmon) that compete directly with seabirds for prey. The mechanisms by which decadal-scale changes in climate affect marine food webs are unclear. The "match-mismatch" hypothesis may best explain inter-specific differences in fish recruitment and long-term changes in fish and seabird populations observed in the Gulf of Alaska during the past 45 years.

SPATIAL AND TEMPORAL TRENDS IN REPRODUCTIVE DYNAMICS OF SEABIRDS IN THE CALIFORNIA CURRENT MARINE ECOSYSTEM: RESPONSE TO EL NIÑO AND LOWER FREQUENCY MARINE CLIMATE CHANGE

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Time series on the reproductive dynamics of storm-petrels, cormorants, pelicans, alcid, and gulls were examined in relation to El Niño and lower frequency marine climate change (i.e., a secular increase in ocean temperatures) to determine the response of seabirds to coastal ecosystem change from the late 1960s to the present. In addition, this study was part of a broader investigation on effects of the 1997-1998 El Niño on coastal ecosystems from southern California through the Bering Sea (funded by NOAA/ERL). Study sites included: Santa Barbara, West Anacapa, and Prince islands in southern California; Ano Nuevo, Alcatraz and Southeast Farallon islands in central California; Yakina Head, Oregon and Tatoosh Island, Washington. As observed during previous El Niño events in the California Current Ecosystem (CCS), there were marked reductions in breeding population size, breeding effort, and reproductive performance and changes in diet composition associated with this El Niño; effects were most apparent in 1998. At Tatoosh Island, due to interactions between murre and eagles, and locally high marine productivity, the climate signal was difficult to detect. In general, there was little direct evidence of increased mortality rates amongst adults, although there were a few seabird die-offs during this period. In comparison with other El Niños, the 1998 event was one of the strongest, yet comparative effects varied between species and trophic levels. In southern and central California, effects of this event also must be viewed in relation to declining trends in the reproductive performance for many species since the mid 1980s. Coupled with long-term ocean warming, population-level effects of strong, recurrent interannual warm-water events may be expected. Indeed, breeding populations of many seabird species in the CCS have either ceased growing or declined, some considerably, in recent time.

SEABIRD BY-CATCH SYMPOSIUM

OFF THE HOOK? INITIATIVES AROUND THE WORLD TO REDUCE SEABIRD BY-CATCH BY LONGLINE FISHERIES

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Seabird by-catch by longline fisheries is of serious conservation concern to albatrosses and petrels, especially of the Southern and North Pacific Oceans. International initiatives to reduce seabird by-catch include the FAO International Plan of Action for Reducing Incidental Catch of Seabirds in Longline Fisheries, which will lead to National Plans of Actions and a postulated albatross Range State Agreement under the Bonn Convention on Migratory Species, being led by the Valdivia Group of Southern Hemisphere Countries for the Environment. Regionally, regulations of the Commissions for the Conservation of Antarctic Marine Living Resources and for the Conservation of Southern Bluefin Tuna have reduced seabird mortality. Nationally, Australia, Japan, New Zealand, South Africa and the USA have adopted mitigation regulations in some of their domestic longline fisheries. Priorities are the adoption of FAO National Plans of Actions by longlining nations; furthering the Bonn Convention initiative; monitoring seabird by-catch in domestic and high-seas longline fisheries, especially Asian, Latin American and pelagic tuna; and improving mitigation measures by commercial development of new line-weighting and under-water setting techniques. The Global Environmental Facility is a possible means of support for implementing effective mitigation measures in developing countries. Unsourced "pirate" longlining and its attendant high levels of seabird by-catch, especially in the Southern Ocean, remains one of the biggest problems to address.

A SEABIRD WORKSHOP: OVERCOMING ROADBLOCKS AND FINDING SOLUTIONS

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The Western Pacific Regional fishery Management Council sponsored a workshop to investigate how seabird mortality in the Hawaii-based domestic longline fishery is affecting the Black-footed Albatross (*Phoebastria nigripes*) population. Experts in seabird ecology, fisheries management and population modeling participated in the three-day workshop convened in the Council offices. Decades of seabird census and banding reports, plus seven years of Hawaii-based longline fishery data were supplied to the workshop participants. Analyses generated from the bird-banding data found that juvenile Black-footed Albatrosses were caught on longline more frequently than adult Black-footed Albatrosses. A series of simulations were conducted to investigate how population removals added onto baseline mortality would affect the sustainable population growth rates. These simulations generated some rather robust conclusions and initiated recommendations for Council consideration.

TRACING AND DEMOGRAPHIC MODELING OF BYCATCH BIRDS: THE CONTRIBUTION OF GENETICS

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Assessing the geographic sources and demographic consequences of bycatch are two important goals in the conservation of the world's seabirds. Large-scale banding operations and satellite tracking offer two potential methods for tracing the origins of bycatch birds, but even the largest sample sizes used in these methods can yield imprecise estimates of the source populations of bycatch birds and the metapopulation context in which bycatch takes place. Molecular genetic markers offer a complementary and non-destructive method for variety of goals toward understanding the biology of by-

catch birds. Genetic markers currently available for such studies include mitochondrial DNA sequences, simple-sequence repeats and intron sequences from the nuclear genome. Genetic markers provide powerful clues to the ancestry and geographic origins of bycatch birds and are essential for estimating rates of immigration into fishing grounds and between breeding colonies. Multi-colony genetic surveys of procellariiform and alcid species routinely challenge the traditional view from banding that seabirds are extremely philopatric. Estimates of gene flow from such studies are critical for informed demographic modeling of bycatch species. Genetic markers frequently yield data addressing long-term, evolutionary times scales but can also be analyzed to delimit short-term management units for conservation. Applications of genetics in bycatch biology, illustrated with examples from albatrosses and alcid, are still in their infancy and the extensive population genetic literature on marine turtles provides useful models.

SET GILLNET EFFORT AND SEABIRD BYCATCH IN THE MONTEREY BAY REGION, CALIFORNIA, 1990-97

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During the 1980's, extensive bycatch of seabirds and marine mammals in central California's set gillnet fisheries prompted a series of area closures and restrictions in shallow waters, which ultimately appeared successful at reducing mortality of the species of primary concern, Common Murre (*Uria aalge*), sea otter (*Enhydra lutris*) and harbor porpoise (*Phocoena phocoena*). The effects of the restrictions, however, were confounded with changes in the distribution of sets and a decrease in total fishing effort in the early 1990's. Since 1994 (after a monitoring program ended), gillnet effort in the Monterey Bay region has again increased dramatically and shifted back into the southern bay, where effort and bycatch previously were high. In this study, updated estimates of

Seabird mortality are presented for 1990-97 based on 1987-94 fishery observer data. The most commonly entangled seabird was the Common Murre, with mortality estimates ranging from 300 in 1993 to 4,000 in 1997 (1990-97 mean = 1,988). Cormorants, grebes, and loons were less frequently observed entangled. The recent increase in gillnet effort in southern Monterey Bay appears to be reflected in higher beach deposition rates for Common Murre in 1997-98 compared to 1992-93. These changes in fishing effort and distribution underscore the importance of considering variability in both fishing practices and seabird distribution when evaluating longterm fishery impacts on seabird populations.

MORTALITY OF MIGRATORY WATERBIRDS IN MID-ATLANTIC COASTAL ANCHORED GILLNETS DURING MARCH AND APRIL, 1998

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The U.S. Fish and Wildlife Service recently completed the first year of a study to assess bird mortality in anchored gillnets in the nearshore ocean of New Jersey, Delaware, Maryland, and Virginia. Twenty five dead birds were observed being removed during 161 net retrievals. This equates to a minimum mortality of 0.16 birds per 300 foot net per set. Based on approximately 14,900 net sets, we estimate 2,387 diving birds were killed, mostly red-throated and common loons.

Beached bird surveys were conducted from 3 to 19 times at 20 locations along the 565 kilometer shore. Two hundred and ten (210) dead diving birds were found on 1,732 kilometers of surveyed beach or 0.12 birds/kilometer. Approximately ten times more dead birds/kilometer were found on beaches within 2 kilometers of at least one gillnet than on beaches without nets. Two methods of estimating mortality based on the beached bird surveys estimated 1,265 and 3,390 diving birds killed per season.

Live birds were counted to 400 m offshore on 590 kilometers of shore with nets deployed within 1 kilometer, and on 953 kilometers of shore with no nets deployed within 1 kilometer. For all diving birds, 10.3 birds/kilometer were counted in nearshore waters without nets and 4.6 birds/kilometer were counted in areas with nets. A vulnerability index was de-

veloped based on foraging behavior, distance from shore, and time in the study area during migration.

BIRD-SCARING LINE AND UNDERWATER SETTING REDUCE SEABIRD BYCATCHES IN LONGLINING

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Seabird bycatches in longline fisheries may cause seabird populations to decline and reduce gear efficiency. Different types of mitigation measures capable of reducing the likelihood of seabird incidental catches have been described, but only a few studies to quantify their effectiveness have been carried out. Two fishing experiments in commercial longlining were performed and two different methods of preventing seabirds from taking baits during longline setting were tested: a bird-scaring line towed behind the vessel and an underwater setting funnel. Bycatch of seabirds, bait losses and catch rates of target species were quantified for longlines set using these mitigation measures and compared with those of longlines set without such measures. During 12 settings in the first experiment, two seabirds were caught when the bird-scaring line was used, 28 when lines were set through the setting funnel and 99 when no device was used. In the second experiment, 11 settings were made for each method, and zero, six and 74 seabirds respectively were caught. The great majority (>95%) of the birds caught were northern fulmar (*Fulmarus glacialis*). The relatively high number of seabirds caught in the first experiment by lines set through the underwater setting funnel was explained by the unfavourable pitch angle of the vessel. The results of both experiments showed that bait loss was lowered using the bird-scaring line, and the second experiment indicated smaller catches of target species by lines set without the use of a mitigation measure.

HOW THE F/V MASONIC REACHED ZERO SEABIRD BYCATCH IN 1998 IN ALASKA

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In response to growing international pressure and threats to the short-tailed albatross (*Phoebastria albatrus*), seabird by-catch regulations were adopted that require fishers to deploy seabird deterrent devices in the Gulf of Alaska and the Bering Sea demersal longline fisheries in 1997. These regulations, which allow a range of alternative strategies, were proposed by industry and were patterned on those developed in the southern oceans and our own history of trying to keep seabirds away from our baited hooks. Alaska fisheries. In order to find the best by-catch reduction strategy for my vessel, I compared several bird bycatch reduction devices and combinations of devices in the Gulf of Alaska during the 1997 and 1998 fisheries for Pacific halibut (*Hippoglossus stenolepis*) and sablefish (*Anoplopoma fimbria*). Devices included towing buoy bags, streamer lines, and boards and increasing the weight of the fishing gear. As a result of my tests, I achieved zero take of seabirds on my vessel in 1998 by increasing the weight of the fishing gear in combination with deploying a streamer line with the fishing gear. Based on my results and that of fellow fishers, the industry is working with resource managers to develop new, more specific seabird by-catch regulations for the 1999 fishing season.

SOLUTIONS AND ROADBLOCKS TO SEABIRD BY-CATCH IN SALMON DRIFT GILLNET FISHERIES IN THE PACIFIC NORTHWEST

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Data from fishery observer programs in the 1993 and 1994 salmon fisheries demonstrated that the Puget Sound gillnet fishery for Fraser River sockeye salmon killed significant numbers of common murre and rhinoceros auklets. The fishery rarely killed marbled murrelets. A multi-year, Washington Sea Grant-industry research program developed and tested gear and methods to reduce seabird bycatch from 1994 to 1996, and generated specific recommendations for regulatory action. In May of 1997, the Washington Department of Fish and Wildlife adopted

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regulations to reduce seabird bycatch in the non-treaty fishery. These required: 1) the use of gillnets modified to include a visual barrier of heavy white twine in the upper net, 2) prohibition of night and sunrise fishing, and 3) scheduling fishery openings that optimize fishing efficiency and avoid periods of high bird abundance. Neither the Washington tribes nor the British Columbia salmon fishery managers adopted these regulations, leaving approximately 90% to 99% of the salmon fishing effort by gillnets in the Puget Sound-Queen Charlotte Straits Eco-region unregulated. Intervention by the Pacific Seabird Group and recent FAO action helped catalyze increased attention to gillnet bycatch in Canada and the Washington tribes. The Puget Sound experience illustrates that solutions to seabird bycatch, once found, are not sufficient to affect changes in fisheries management or seabird conservation.

RECENT DISTRIBUTIONAL RECORDS OF SHORT-TAILED ALBATROSS AS A TOOL FOR LONG-LINE FISHERIES MANAGEMENT

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The Short-tailed Albatross (*Diomedea albatrus*) is vulnerable to accidental catch in Alaska long-line fisheries for species such as Pacific Cod (*Gadus macrocephalus*) and Sablefish (*Anoplopoma fimbria*). Using ArcInfo, we plotted the distribution of this species based on sight records and bycatch. Short-tails occur year-round in Alaskan waters but peak in summer. They are strongly associated with shelf-edges and seamounts in the Gulf of Alaska and along the Aleutian chain and with the edge of the deeper basin of the Bering Sea. Adult and immature distributions do not appear to differ. Short-tails occur in waters less than 50 m depth, but increase in frequency with depth, being common-

est at 150 - 200 m depths. This information may help fishermen avoid areas of high concentrations of albatross or take special precautions while setting their long lines in such areas. The distributional maps may be found on the Web at: http://www.uaa.alaska.edu/enri/aknhp_web/biodiversity/zoological/spp_of_concern/spp_status_reports/albatross/albatros.html

SEABIRD BY-CATCH AND THE CONSERVATION TRAP: BLIND OR CRYING WOLF

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Inadvertent capture of charismatic megafauna in marine fisheries has provoked public outrage, finger pointing and political maneuvering, leading to a rush to regulate with or without solutions. Regulations have included modification of gear and/or procedures, time and area restrictions, and quota reductions. In certain cases, fisheries are threatened with closure. Can these measures be justified on conservation grounds? Although many studies of seabird by-catch quantify seabird fishery mortality, few link that mortality to declines in specific populations. Conversely, studies documenting population declines rarely parse out causality. The wide range of seabird distribution, the size, spatial and seasonal range of fisheries, the rarity of by-catch events, the frequency and quality of seabird population studies, and the inherent lag in measurable demographic effects in long-lived species all frustrate the linkage of effect and cause the conservation trap. This may lead to two problems: 1) Crying Wolf: asserting that there is a problem when one does not exist, or 2) Being Blind to the Obvious: failing to recognize a serious conservation problem when it in fact exists.

SEABIRD MORTALITY IN THE PATAGONIAN TOOTHFISH LONGLINE FISHERY

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Patagonian toothfish (= Mero or Chilean sea bass) is harvested by longliners and trawlers from the waters around sub Antarctic islands and from the coastal waters

of Chile and Argentina. Fisheries south of the Antarctic Polar Front (about 50 degrees south) fall under the jurisdiction of the Commission for the Conservation of Antarctic Marine Living Resources which promotes a suite of conservation measures, including those to protect seabirds. Seabird mortality in the toothfish longline fishery (mortality in the trawl fishery is virtually non-existent) ranges annually between 50,000 and 100,000 birds, of-fake rates that would be expected to produce precipitous declines in populations of species affected. At-sea experiments were conducted to derive longline sink rates, and line weighting regimes, that would render deployed baits unavailable to seabirds (since toothfish vessels use weighted lines it is intuitive to vary sink rate in efforts to reduce seabird deaths). Sink rates in excess of 0.3 m/sec were considered necessary to eliminate takes of black-browed albatrosses, giant petrels and wandering albatrosses. This sink rate could be achieved by deploying 4 kg weights every 40 m or so on longlines (weights in excess of 50 m distance made no difference to line sink rates).

PROBLEMS WITH PIRATES: TOOTHFISH LONGLINING AND SEABIRD BY-CATCH AT THE SUB-ANTARCTIC PRINCE EDWARD ISLANDS

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Longlining for Patagonian Toothfish in the South African Exclusive Economic Zone around the sub-Antarctic Prince Edward Islands commenced in 1996. Seabird by-catch data were obtained from observers aboard 21 sanctioned fishing trips (7.5 million hooks), during 1996-1998. 1421 birds of 10 species were reported killed. White-chinned Petrels (*Procellaria aequinoctialis*) predominated; with large numbers of giant petrels (*Macronectes* spp.) and mollymawks (*Thalasarche* spp.). Most were male breeding adults. Average seabird by-catch rate in 1997-98 was 0.117 birds per 1 000 hooks,

less than half that (0.289) reported in 1996-97. More than 1% of four local breeding populations were killed during the 1996-97 season. Low reproductive rates mean these levels of mortality are not sustainable, resulting in local population declines. The greatest improvement in bycatch relative to 1996-97 was among mollymawks, due to a decrease in daytime setting and increased use of streamer lines. Despite considerable improvements relative to the 1996-97 season, further efforts are needed to ensure that fishers adhere to permit conditions. The fishery should be closed during February to mid-March when White-chinned Petrels are caught in greatest numbers. Mortality from the unsanctioned (illegal and unregulated) fishery is the gravest concern, since it involves roughly 10 times more effort than the sanctioned fishery and almost certainly has a greater bird by-catch rate.

INDUSTRY INITIATIVES IN SEABIRD BYCATCH AVOIDANCE

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In 1995 freezer-longliners fishing off Alaska took two short-tailed albatross, and a third in 1996. The birds are highly endangered, and the news came as a great shock to the longline industry. The North Pacific Longline Association promptly developed seabird avoidance regulations through an industry notice-and-comment process and submitted them to the North Pacific Fishery Management Council in the expectation that the regulations would be modified as more information on seabird bycatch becomes available. In December of 1996 the Council adopted the regulations, which became effective in May of 1997. Recently the freezer-longliner industry has recommended analysis of the use of lining tubes and line setting devices to improve seabird avoidance. The National Marine Fisheries Service has recommended regulatory changes for the same purpose. Adoption of the regulatory amendments will be contingent in part on the results of research on the effectiveness of seabird avoidance techniques to be conducted by the University of Washington Sea Grant Program, with cooperation by the National Marine Fisheries Service, the US Fish and Wildlife Service, and the

longline industry.

SEABIRD BYCATCH IN LONGLINE FISHERIES OFF ALASKA

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Seabird bycatch is a serious conservation issue in Alaska and in other regions of the world. Fifteen species of seabirds are reported as being incidentally caught in groundfish longline fisheries in the Bering Sea/Aleutian Islands (BSAI) and Gulf of Alaska (GOA) fishery regions. The BSAI groundfish longline fishery is characterized by relatively large catcher-processor vessels and from 1996 to 1998 accounted for 98% of the total BSAI longline harvest. Approximately 128 million hooks are deployed in the BSAI annually. In contrast, the majority of the GOA longline harvest is from smaller catcher vessels, from 1996 to 1998 accounting for 78% of the harvest. Approximately 40 million hooks are deployed in the GOA annually. The total estimated average annual mortality of seabirds in the Alaskan longline groundfish fishery was almost 14,000 birds between 1993 and 1997 with about 85% of the total occurring in the BSAI region. The estimated bycatch rate in the BSAI and the GOA for this period is 0.09 birds/1000 hooks and 0.06 birds/1000 hooks, respectively. The estimated bycatch ranged from a low of about 9,300 birds in 1993 to a high of about 20,200 birds in 1995. The bycatch of Northern Fulmars represented about 67% of the total bycatch while Laysan and Black-footed Albatrosses accounted for about 5% and 4%, respectively, of the total estimated seabird bycatch. During the period of 1993 to 1997 there were 3 endangered short-tailed albatrosses reported taken in the longline groundfish fishery.

In May 1997, the National Marine Fisheries Service, (NMFS) implemented regulations to require seabird deterrent devices and measures to reduce the bycatch in groundfish longline fisheries in Alaska. In 1998, NMFS also implemented similar regulations for the Pacific halibut

fishery off Alaska.

RESULTS OF SEABIRD AVOIDANCE EXPERIMENTS AND OBSERVATIONS OF BYCATCH REPORTED BY FISHERMEN TO IPHC SAMPLERS IN ALASKAN AND CANADIAN PORTS IN 1998

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Regulations implemented in 1997 for groundfish and in 1998 for Pacific halibut to require seabird avoidance devices in Alaskan longline fisheries also required monitoring of the effects of the regulations. The lack of observer coverage on halibut vessels precludes direct observations of seabird bycatch. At the request of the U.S. Fish and Wildlife Service (FWS) and the U.S. National Marine Fisheries Service, the staff of the International Pacific Halibut Commission (IPHC) interviewed Pacific halibut longline fishermen in Alaska (and British Columbia) to collect data concerning bycatch of seabirds and observations of short-tailed albatross. Tori lines and towed buoy bags were the most common avoidance devices, and had reported bird bycatch rates among the lowest of devices used. The reported seabird bycatch rates for the halibut fishery in 1998, after implementation of the avoidance regulations, were about 10-15 percent of the rates reported by FWS for the groundfish fisheries before the avoidance regulations. Either the avoidance regulations worked, the fishermen underreported seabird bycatch, a bird bycatch difference occurs between groundfish and halibut fisheries, or all three. Highest reported seabird bycatch in May and reported sightings of short-tailed albatross through the summer were consistent with previous reports. However, fishermen in some areas reported no seabird bycatch, a likely indicator of underreporting. The IPHC staff seeks comments on the suitability and desirability of collecting seabird bycatch data with interviews, as long as direct observations from observers are not available.

During a longline survey in the Gulf of Alaska, IPHC staff alternated deployment of a bird bag with no bird bag as a pilot experiment to evaluate methods that might be employed in a larger comparison of effectiveness of bird avoidance devices. Thirteen sets, six with bird bag de-

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ployment and seven without, caught no seabirds. Seabirds attacked longline gear about half as often when a seabird avoidance device was used compared to sets without a device. Longline sets made with the bird bag had proportionately more birds flying than sitting in the vicinity of the longline gear.

BIRD INTERACTIONS WITH SALMON DRIFT GILLNETS IN PRINCE WILLIAM SOUND, ALASKA: 1990 AND 1991

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Marine bird interactions with the Prince William Sound salmon drift gillnet fishery were documented by observers that monitored 9,041 net retrievals in 1990 and 1991. Of 2,291 birds observed approaching nets, 90 (3.9%) became entangled and died (in fewer than 1% of observed sets each year) and 13 were released alive. Marbled murrelets and common murre were the most common birds taken, representing 47 and 22 of the 90 observed mortalities, respectively. Marbled mur-

relet mortality was documented in both years, with extrapolated take estimates of 1229 and 263 in 1990 and 1991, respectively. Common murre accounted for 22 of 53 bird deaths observed in 1991 (total estimated take of 433); all were observed prior to 22 June. No murre mortality was observed in 1990 but observer effort was initiated on 10 June that year. Characteristics of the fishery, observer effort, and spatial and temporal (annual, seasonal, and diel) patterns of entanglement are discussed.

ORAL PRESENTATIONS

HABITAT EVALUATION FOR MARBLED MURRELETS IN LARGE, CONTINUOUS FORESTS OF COASTAL BRITISH COLUMBIA

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In comparison to the USA, where Marbled Murrelet (*Brachyramphus marmoratus*) habitat is largely fragmented, much murrelet habitat in Canada is continuous and lies within pristine watersheds. Consequently, the delineation of distinct stands and the association of occupied behaviours with specific forest types is difficult. New forest management that considers wildlife requirements relies on information on habitat suitability within large expanses of old-growth forest. These large, continuous forests necessitate a method of prioritisation which takes advantage of mapped information. Furthermore, the biases, unwanted variation, and technical difficulties in collecting adequate murrelet activity data caused us to emphasise vegetation sampling for our evaluation of habitat suitability.

Based on data collected during four years of Marbled Murrelet inventory by the Ministry of Environment, Lands, and Parks, we designed a habitat suitability index for the Marbled Murrelet as a tool for effective habitat evaluation. It allows a prioritisation of habitats based on mapped information, such as found on the digital Vegetation Resources Inventory maps recently completed in Clayoquot Sound, British Columbia. Our habitat suitability index is based on forest stand attributes (tree height, stand age, vertical composi-

tion, canopy closure and basal area) and spatial variables (altitude and distance from ocean). The index was used in conjunction with a Geographic Information System to rank and map habitats of importance to Marbled Murrelets in the Urus watershed.

The results are clear, understandable maps which categorise habitat as either important, sub-optimal or unsuitable for Marbled Murrelets and can be used by conservation managers not intimately familiar with murrelet habitat requirements.

TROPICAL SEABIRD FORAGING ECOLOGY

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Tropical seabirds forage in waters low in productivity relative to most non-tropical systems. This has profound implications; most tropical species must range widely and all are confined to forage essentially in two dimensions. Foraging strategies reflect these constraints. The single most important foraging strategy for tropical seabirds is to feed in association with subsurface predators, primarily tunas. In the tropical Pacific, these feeding opportunities support, at least in part, a majority of species, probably a majority of individuals for some species, indirectly determine abundance and distribution, and provide a resource around which a complex community with a predictable structure is centered. Other foraging strategies include solitary feeding and scavenging; few species use these

exclusively, and those that do are rare. Nocturnal feeding has been observed regularly in only one species; at least two others purported to be nocturnal feeders obtain mesopelagic prey during the day by associating with subsurface predators. Feeding in association with oceanographic features is important for non-tropical seabirds, but its significance in the tropics remains unknown. Important topics for future research include precise quantification of seabird dependence on tunas, on nocturnal feeding, and on oceanographic features as prey aggregating mechanisms, and investigation of scale-dependent patterns. Most importantly, we suggest that efforts be focused on re-establishing the former abundance and diversity of tropical seabird communities, catastrophically altered as a result of human colonization of islands. It is only with a somewhat intact and functioning community that we can pursue the answers to ecological questions.

EFFECT OF TRANSECT LENGTH ON ABILITY TO DETECT SEABIRD POPULATION TRENDS

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Accurate and robust detection of population trends is critical for understanding and interpreting seabird conservation priorities and effectiveness. At-sea population monitoring of Marbled Murrelets (*Brachyramphus marmoratus*) uses near-shore line or strip transects to estimate population density and infer population

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trends. While much attention has been given to placement of these transects, there has been little consideration of how transect length may affect ability to detect population trends. There is a trade-off between sample size and variance when using short or long transect lengths. The coefficient of variation (CV) is reduced with longer surveys because spatial variation is masked. Shorter surveys have higher CVs due to spatial variation but lower standard errors due to a larger sample size. The result is that either choice has a similar ability to detect trends for high population densities. However, Marbled Murrelet densities are often low, especially in California and Oregon. Shorter transects may therefore result in many segments with small numbers close or equal to zero. This decreases power to detect negative density trends over time. Additionally, line transect (Distance) sampling methods require a high number of detections per transect to calculate reliable detection curves. In areas of low to medium density, short transects with small numbers of birds will not generate reliable detection curves. Power to detect density trends for transects from 2 to 100 km in length illustrate these concepts and suggest that longer transects should be used for trend analysis. If data is collected in short transect lengths, it should be combined before trend analysis.

CALICUM IN PENGUINS EGGS: DOES DIET MATTER?

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Magellanic penguins (*Spheniscus magellanicus*) produce eggs with thick shells and must mobilize calcium quickly for eggshell formation. Unlike birds that fly through the air, penguins have solid bones and may be able to mobilize calcium from bones. However, use of bone calcium is likely to be costly, particularly in Magellanic penguins, a species in which females fast for several weeks after laying their eggs. Alternatively, diet adjustments may play a significant role in calcium availability. We tested this hypothesis by comparing the diet of Magellanic males and females prior to egg laying and by comparing the diet of females prior to and after egg laying. Early in the season, females were significantly more likely to have shells in their stomachs than

males. Later in the season, shells were largely absent from the stomach contents of both sexes and there was no significant difference between the sexes in occurrence of shells in stomach contents. We conclude that ingesting shells may be one mechanism that females use to increase the availability of calcium for eggshell formation.

ON THE IMPORTANCE OF SMALL MAMMALS AS NEST PREDATORS OF MARBLED MURRELETS

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Arboreal rodents are known from the literature to be occasional predators of vertebrates. Recent work on the Olympic Peninsula, Washington has identified deer mice, Douglas' squirrels, and northern flying squirrels as potential nest predators of the marbled murrelet. More detailed investigation of this potential has begun to determine (1) if deer mice, Douglas' squirrels, and northern flying squirrels will attack murrelet-sized nestlings under natural conditions and (2) the influence of nestling size, egg size, and nutritional stress on the predatory behavior of wild-caught rodents. In captivity, deer mice and flying squirrels have been seen to prey upon eggs and nestlings. Both hunger and nestling size seem to influence predation by captive animals. Field trials have verified that deer mice are predators of murrelet-sized nestlings in the wild. We monitored 22 artificial canopy nests containing nestling pigeons as surrogates for nestling murrelets. Nine nests were in place for 30 nights or until predation. Of these, 6 nests were depredated (2 by deer mice), and 3 nests were active for 30 nights without depredation. Nineteen neutral interactions with potential predators were recorded (7 flying squirrels, 6 deer mice, 1 Douglas' squirrel, 1 Townsend's chipmunk and 3 Stellar's jays). Data from captive and field trials will be presented, and preliminary trends discussed.

MARBLED MURRELET RADIO TELEMETRY IN CENTRAL CALIFOR-

NIA IN 1997 AND 1998: A REDUCED BREEDING EFFORT NOTED IN AN EL NIÑO YEAR

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In 1998 we radio marked 19 birds, all with brood patches indicating egg-laying. Sex ratio was 13 females:6 males (9 females:17 males in May/June 1997). Compared to 1997, radio-marked murrelets exhibited reduced breeding effort, especially relaying, based on several factors: 1) apparent reduction in prey abundance or availability due to El Niño conditions; 2) late arrival in Año Nuevo Bay; 3) no nests were found (five nests in 1997); 4) few birds were detected inland; and 5) more birds foraged in kelp beds near Santa Cruz. A distinct weight gain was apparent from May-August 1997, but a slight decrease occurred in 1998. Five mortalities occurred in 1998 (two mortalities in 1997); one apparently the result of peregrine falcon predation, the remainder likely caused by a combination of factors. Necropsies were inconclusive but revealed a lack of cardiac and abdominal fat. Four signals were lost within nine days of deployment. Excluding these and known mortalities, mean tracking duration was 45 days. Two long distance movements 200 km south were documented on 18 June and 14 July.

USING MULTI-SCALE INVENTORY AND RESEARCH TO CONSERVE MARBLED MURRELETS IN CLAYOQUOT SOUND, BRITISH COLUMBIA

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Clayoquot Sound, Vancouver Island is an area of high profile forest conflicts which supports some of the largest concentrations of breeding Marbled Murrelets in North America. In 1994, the Province of British Columbia appointed an international Scientific Panel to make recommendations regarding forest management in Clayoquot Sound. The Scientific Panel made a strong recommendation that: "particular species known or suspected to be at risk are monitored and their habitats protected."

Our goal is to provide quantitative information on critical habitats for Marbled Murrelets in Clayoquot Sound. We gathered data at a full range of spatial scales over three years. Boat surveys were used to estimate numbers and marine distribution of murrelets, high frequency radar allowed us to count numbers of murrelets entering specific watersheds, standard audio-visual surveys determined occupancy, vegetation surveys correlated activity with habitat parameters and tree-climbing determined nesting density.

Sea-surveys showed that there is significant variation in year to year numbers and distribution of Marbled Murrelets. Using sea survey and radar data we estimate the current population of Marbled Murrelets in Clayoquot Sound to be 6000-8000 birds. High radar detection numbers correlated with size of watershed and amount of remaining valley-bottom timber. We found that occupied detections significantly correlated with large (both tall and large diameter) moss-covered coniferous trees in low-elevation stands. A combination of ecosystem classification, three years of detection data and GIS mapping analyses was used to map habitats of importance. Tree-climbing of random trees with potential platforms demonstrated that Marbled Murrelets nest in very low densities (.18 - .28/ha) in the Ursus watershed. We continue to use this information in planning processes delineate important habitat and management zones for Marbled Murrelets in Clayoquot Sound, and other coastal areas of British Columbia.

EVALUATING THE MARBLED MURRELET SURVEY PROTOCOL WITH RADAR

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We compared concurrent radar and

audio-visual observations during 82 mornings in 1997 and 1998 to help evaluate the Inland Forest Survey Protocol (IFSP) for Marbled Murrelets. Each morning, radar data were collected on all murrelet targets that passed over the area surrounding an audio-visual observer. For each observation, we determined whether radar, audio-visual observer, or both had detected the murrelet. We found that 21% of murrelet movements at occupied stands occur before IFSP survey start time. Because of the dark conditions and because the birds that flew in early were silent, a very small proportion (6%) of these "early" birds were detected by the audio-visual observer. For the entire morning, observers conducting IFSP surveys missed an average of between 89 and 95% of the murrelets (depending on the method used to calculate the percentage). Because of the large within-site and among-site variation in the proportion of murrelets that were detected on IFSP surveys, we believe that it is inappropriate to use those percentages as a correction factor for IFSP counts. Some overestimation of the number of birds using a stand also was observed: 7% of the murrelets that were detected during IFSP surveys were not even using the stand that was being surveyed. Further, a minimum of 3% of detections was double-counted by audio-visual observers. We discuss the implications of our results for interpreting data collected using the Inland Forest Survey Protocol.

MARINE POLLUTION: A SERIOUS PROBLEM FOR BREEDING ALBATROSS

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Dumping plastic at-sea has been prohibited by an international Convention, MARPOL Annex V (e.g., MARPOL is an acronym for Marine Pollution), for at least a decade, yet plastic ingestion by seabirds has increased and plastic debris continues to wash ashore on the Hawaiian Islands. Either there must be a large derelict floating mass of plastic that accumulated prior to the enforcement of MARPOL Annex V, or people are still dumping garbage over the side of their vessels. If people are dumping fishing gear or light sticks at-sea, then according to the U.S.

Coast Guard (USCG) this event is rarely witnessed. Without hard evidence, such as identifying marks to the origin of the plastic, it is difficult for USCG to issue MARPOL Annex V violations. Recently, concern has been expressed to the Western Pacific Regional Fishery Management Council regarding the numerous light sticks and cigarette lighters found in the remains of albatross chicks on the Northwestern Hawaiian Islands. Adult seabirds ingest plastic items while foraging for food at-sea and then inadvertently feed the plastic to their young. Albatrosses tend to follow ships, and as opportunistic foragers, they quickly learn that the ships can be a source of food. Plastic garbage lost intentionally or unintentionally from ships could easily be the source of their plastic in the marine environment. But as the sources for plastic pollution are varied and complex, understanding and identifying the origins of plastics is a first step to stopping the pollution.

GENE FLOW AND POPULATION DIVERGENCE IN MURRES

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Discriminating among the four modes of speciation (allopatric, peripatric, sympatric and parapatric) when studying the evolutionary history of an organism can be difficult. In highly vagile seabirds such as murres, opportunities for classical allopatric divergence seem to be rare, and limited to a few glaciation events. Morphological investigations have led to the identification of many subspecies of murres, demonstrating that significant morphological variation exists among them, and that natural selection may be responsible for at least some of the differences. Both murre species are highly philopatric, although dispersal of birds to non-natal colonies is not as rare as once thought. We believe that many modes of speciation/divergence are responsible for the current genetic structure of murres. Philopatry, together with selection to adapt to local environmental conditions, may be resulting in parapatric divergence. Isolation in high northern breeding grounds, coupled with nearby overwintering sites

in polynyas may be resulting in peripatric differentiation. Allopatric divergence of murre has already been demonstrated: the Atlantic and Pacific populations of each species have clearly evolved in allopatry. Methods we are using include genomic microsatellite and intron assays, and sequencing of the mitochondrial control region. Other preliminary results will be presented at the meeting.

FEEDING ECOLOGY OF KITTLITZ'S MURRELET IN PRINCE WILLIAM SOUND, ALASKA

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We studied the feeding ecology of Kittlitz's (*Brachyramphus brevirostris*) Murrelet in Prince William Sound, Alaska, during the summers of 1996-1998 in relation to at-sea environmental characteristics and other attributes. We examined the effects of time of day (morning, afternoon), season, year, tidal stage (rising, falling), current strength (weak, moderate, strong), habitat type, water depth, distance from shore, distance from freshwater input, shoreline substrate, percent ice cover, water clarity, sea-surface temperature, sea-surface salinity, and survey type (nearshore, offshore) on whether or not birds were feeding. Of these variables, only survey type, season, year, habitat type, ice cover, distance to shore, depth, and shoreline substrate were significant in affecting feeding frequency. Kittlitz's Murrelets primarily ate the common forage fishes that occurred in these glaciated fjords, although both the low number of birds seen with fishes and the cold environmental conditions in these bays in early summer suggest that they may be foraging extensively on pelagic invertebrates at that time. Both the species and mean sizes of fishes eaten by the Kittlitz's Murrelet in summer overlapped extensively with those of fishes eaten by the closely related Marbled Murrelet (*B. marmoratus*), which also is the species that the Kittlitz's Murrelet occurred most often with in mixed-species foraging flocks. Thus, the two species may compete for prey during the summer.

MARBLED MURRELETS CAN BE VOCALLY "FINGERPRINTED"

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We analysed the variability in the vocalisations of the Marbled Murrelet (*Brachyramphus marmoratus*) and tested if individuals could be recognized by their calls. A literature review revealed that essentially all seabird species showed vocal individuality. Vocalizations are usually essential in maintaining long-term pair bonds, so this universality was not surprising. Vocalisations of Marbled Murrelets have not been investigated in this capacity. We describe the murrelet's vocal repertoire of nine call types and two non-vocal sounds. Humans were able to visually discriminate the sound spectrograms of calls made by different birds. The calls were not highly stereotyped in successive renditions, but showed gradations. Graded vocalisations allow almost infinite variations in call types, but we recognized certain components (elements) of the calls that reoccurred in many call types. Elements were either strongly harmonic or tonal in nature. Call types were placed in call groups based on acoustic features, grading patterns, and contextual use. Vocal individuality was found in the *keheer* call, and the most individually recognizable features were: call duration, and the frequencies and durations of the tonal portions of the call. Using these characters, a cluster analysis had 100% success in discriminating 8 individuals using 20 calls. This suggests that vocal fingerprinting is possible. Vocal recognition of individuals could help interpret the behaviours presently used in inland surveys for assessing presence and occupancy. It could also be used to improve population estimates within forest stands.

PREDATION BY KEEN'S MICE ON SEABIRD EGGS: EVIDENCE FROM STABLE ISOTOPE ANALYSES

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Evaluating the consumption of seabird eggs by predators can be difficult. Egg-

shells do not preserve well in stomach acid and unless fresh, egg yolk and albumen can be almost impossible to identify a few hours following their consumption. However, stable isotopes were recently used to analyze diets of seabird predators on Langara Island. This successful application provided us with the opportunity to examine egg predation by endemic Keen's Mice (*Peromyscus keeni*) on Triangle Island, British Columbia. We examined stable-carbon ($\delta^{13}\text{C}$) and nitrogen ($\delta^{15}\text{N}$) isotope composition in muscle and liver tissues of mice, abandoned eggs of Rhinoceros Auklets (*Cerorhinca monocerata*) and Cassin's Auklets (*Ptychoramphus aleuticus*), and other available prey items from three regions of Triangle Island. Carbon isotopes can be used to distinguish marine vs. terrestrial diets, whereas nitrogen isotopes serve as useful indicators of trophic position. Mice were segregated into two groups corresponding to areas where only Cassin's Auklets bred or where they bred Rhinoceros Auklets. Isotopic signals from mice eating seabird eggs showed much smaller variances than signals of mice trapped before seabirds began to breed, suggesting that mice diversify their diet in winter.

PATTERNS OF PRIMARY AND SECONDARY MOLT IN LAYSAN AND BLACK-FOOTED ALBATROSSES: COMPLEX PATTERNS ALLOW FEATHER REPLACEMENT TO MATCH FEATHER WEAR

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Albatrosses are incomplete molters, which means generally they replace only a portion of their flight feathers during a single season. Incomplete molt suggests a trade-off between time available for molting and time available for reproduction. Evidence from annually breeding albatrosses shows that successful breeders molt fewer feathers between two consecutive breeding seasons compared to unsuccessful breeders that abandon the colony early. Successful breeders of biennially breeding albatrosses skip a year of breeding and can undergo a complete molt, whereas unsuccessful breeders which leave the colony early molt fewer feathers and attempt to breed the follow-

ing year. We examined 104 actively molting, non-juvenile Laysan and Black-footed Albatrosses caught in driftnets in the North Pacific during the non-breeding season in 1990-91 to look at the rules of feather replacement. Both Laysan and Black-footed Albatrosses divide the primary and secondary molt into a total of four series. Each series shows variable feather replacement. There is a hierarchy of replacement between series that depends on a) the average amount of wear received by a series, b) the average age of feathers in a series, and c) the total number of feathers to be replaced in the wing. Multiple molt series and variation in the frequency of replacing feathers within each series allow the pattern of feather replacement to more accurately match the pattern of feather wear, thereby minimizing the cost of maintaining quality feathers.

PARENTAL EFFORT AND PREY SELECTION BY MALE AND FEMALE CRESTED AUKLETS ON BULDIR ISLAND, ALASKA

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For three breeding seasons we investigated whether male and female Crested Auklets adopt similar roles in parental care. We found intersexual differences in feeding and brooding rates between males and females, particularly during the first two weeks of chick rearing. Females fed their chick at significantly higher rates than males, whereas males guarded their chick more. We hypothesized that males brood more because they are more aggressive in agonistic interactions and are therefore better at protecting their chick from aggression by prospecting birds. To explore how vulnerable unattended young chicks were we placed clay model chicks in old crevices during three different time periods and found high rates of attacks occurred during each trial (71-87%). We also examined prey selection during the chick rearing period by males and females and found that males selected more euphausiids and fewer copepods than did females. Crested Auklets have developed well defined sexual roles in parental care, especially early in the chick rearing season. Consequences of this division of la-

bor may be sexual differences in mortality; females may be more vulnerable to predators with increased frequency of movement to and from the colony. Also, inter-sexual variation in prey selection may be related to the dimorphism of bill shape; males have a much larger bill that may be suited for larger prey items such as euphausiids.

SENSITIVITY OF BREEDING PARAMETERS TO FOOD SUPPLY: A CONTROLLED FEEDING EXPERIMENT IN A KITTIWAKE COLONY

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To determine if food availability is responsible for the chronic breeding failure of Black-Legged Kittiwakes (*Rissa tridactyla*) on Middleton Island, AK, we supplementally fed herring *ad libitum* to non-captive adults and nestlings in 1996 and 1997. Birds nested on an abandoned radar tower that provided uniquely accessible sites for experimentation and manipulation. About 150 nest sites were fitted with feeding tubes and sliding, one-way glass windows that permitted us to monitor closely a number of breeding parameters in fed and unfed pairs. Our results indicate that kittiwake productivity was dramatically increased when birds were fed and that this increase occurred through enhancements of breeding performance at all stages of the breeding season. Six measures of breeding performance were especially sensitive to food supply: laying and hatching dates, volume of the "B" egg, foraging trip lengths, chick growth, adult attendance during chick rearing, and chick survival. We suggest these parameters will be the most useful indices of food availability at kittiwake colonies under natural conditions. Breeding parameters less sensitive to food supply included courtship behavior, chick aggression, age of peak weight and fledging ages.

ADULT PREY CHOICE AFFECTS CHICK GROWTH AND REPRODUCTIVE SUCCESS OF PIGEON GUILLEMOTS

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Pigeon Guillemots (*Cephus columba*) forage near shore and feed their chicks both demersal and schooling fishes. Between 1979 and 1997, we studied chick diet, chick growth rate, and reproductive success of Pigeon Guillemots at Naked Island, Prince William Sound, Alaska, to identify factors limiting guillemot breeding populations. We found evidence for prey specialization among individual adult guillemots, but detected no differences in reproductive success between specialists and generalists. We did, however, find significant differences in chick growth and reproductive success between pairs that fed their chicks > 50% high-lipid schooling fishes (predominantly Pacific sand lance *Ammodytes hexapterus* and Pacific herring *Clupea pallasii*) and those that delivered > 50% low-lipid demersal fishes (e.g., sculpins *Cottidae* spp., blennies *Stichaeidae* and *Pholididae* spp.) and gadids (*Gadidae* spp.). The improved growth of guillemot chicks fed high-lipid fishes may be a function of the higher energy density of these prey, however, pairs delivering high-lipid fishes had higher delivery rates than pairs delivering low-lipid fishes. Chick diet showed high annual variation from 1979-1997, largely because of fluctuations in Pacific sand lance. Regression analyses suggest that at the population level, chick growth is affected by the percent occurrence of high-lipid fishes in the diet. We conclude that guillemot chicks grow fastest, and reproductive success is highest, when high-lipid schooling fishes comprise a major portion of the diet.

SURVIVAL AND BEHAVIOR OF WESTERN GULLS FOLLOWING EXPOSURE TO OIL AND REHABILITATION

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ABSTRACTS

Legislatively mandated rehabilitation of wildlife damaged in coastal oil spills has resulted in professionally supervised rehabilitation in California. We evaluated the survivorship and behavior of western gulls that were rehabilitated following the *Platform Irene* spill in California. Western gulls were selected because an adequate sample was available and controls could be obtained.

Three test groups were established: oiled and rehabilitated (n=7), rehabilitated but not oiled (n=10), and controls (captured and released; n=10). Radio transmitters were attached. Aircraft were used to locate birds twice a week for the first 3.5 months, and once a week thereafter. Flight patterns were extensive once radios began to fail (to ensure that all radios were found) and extended from central Baja California to the Oregon-Washington border. The last two radios in the oiled group expired 235 days following release.

One control bird died 115 days after release. The first radio expirations occurred at 127, 52, and 99 days after release for oiled, rehabilitated only, and control birds, respectively. The rate of disappearance of radios was greatest for the control group and lowest for the oiled group ($p < 0.001$); if disappearing radios represented mortalities, such mortalities were fewest in the oiled group. We also examined free-ranging behavior differences between groups by comparing the sizes of areas used by the gulls (adaptive kernel and minimum convex polygon), and shifts in the centers of activity.

COMMON MURRE (*URIA AALGE*) MORTALITY ALONG WASHINGTON OUTER-COAST BEACHES: PATTERNS AND IMPLICATIONS FOR BREEDING POPULATIONS

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We marked bird carcasses with a unique combination of colored cable ties on the bill, wings and/or legs, or we removed them for necropsy analyses. For all birds, we collected data on species, age class, evidence of breeding, indices of body condition, and carcass mass. In all years, Common Murres (*Uria aalge*) composed

the majority of beached birds (79% of 1800 birds in 1997). Deposition rates (murres/mile/week) were highest during the El Niño year of 1997 and lower in both 1996 and 1998, a pattern consistent with a similar study conducted around the 1982-1983 El Niño. Necropsies were performed on murres collected in 1997 and 1998 to verify sex and breeding status. The sex ratio of murres sampled was strongly female-biased for reproductive adults (those with brood patches) but not for non-breeding adults. In mid- to late June, females represented 75-100% of the breeding murres sampled on both the northern and southern Washington coast, decreasing to 35% of those sampled by late July. Evidence suggests that food supply was low around many murre breeding colonies in Oregon in 1997 and 1998 causing a large percentage of adult birds to abandon their colonies. We suggest that the physiological cost of egg production by females is the primary cause for the differential mortality rate between males and females.

NEST SITE SELECTION BY MARBLED MURRELETS ON THE OLYMPIC PENINSULA, WASHINGTON

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We examined habitat selection of the Marbled Murrelet utilizing use versus availability analyses and described the characteristics of Marbled Murrelet nests on the Olympic Peninsula, Washington. Nests were found in 1996 (n=4), 1997 (n=15), and 1998 (n=10). Twenty-nine nests were located using intensive, systematic tree climbing methods in 6 sites of varying age and tree species composition. All 1,545 potential nest trees in sixty random plots (40 meter radius) were climbed. Habitat variables were measured and analyzed at four hierarchical scales at nest and non-nest sites; including stand, plot, tree, and limb/platform levels. Western Hemlock (n=25) and Sitka Spruce (n=2) trees appeared to be selected for nesting, with no nests located in Western Red Cedar or Silver Fir. Three nests were located

in Douglas Fir trees at sites on the north side of the Olympic Peninsula where Douglas Fir is often the sole dominant tree species. The selection of particular tree species for nesting has major implications on how land managers: 1) assess habitat quality; 2) protect nesting habitat; 3) improve habitat quality; 4) develop new habitat and; 5) gauge the contribution of particular forest types to the conservation of the population. We also examined differences in microclimatic conditions (humidity, temperature, solar radiation) between a sample of nest and non-nest plots and analyzed whether edge effects lead to degradation of nesting habitat.

TESTING ASSUMPTIONS OF THE LINE TRANSECT SAMPLING METHOD USED TO ESTIMATE MURRELET DENSITIES AT SEA

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Applying distance sampling techniques to marine surveys for Marbled Murrelets may provide biologists with a powerful yet practical methodology for estimating density of populations and monitoring changes in density over time. Unbiased estimates of density can be obtained using the line transect sampling method only if certain assumptions are met. These assumptions are that birds directly on the line are always detected ($g(0) = 1$) and that birds are detected at their initial location, prior to any movement in response to the vessel. We examined the validity of these two assumptions by placing an independent observer behind the two primary observers positioned on the bow of survey vessels conducting surveys for murrelets and other seabirds in Oregon and Washington. The independent observer, using binoculars, located birds near the transect line an average of 156 m ahead of the survey vessel before movement or avoidance would be expected to occur, and then tracked the bird as the boat passed. Birds observed near the transect line moved an average of 3.3 m away from the line before detection by the standard observers. On average, 9.2 percent of the birds near the transect line were not detected by ei-

ther primary observer. Using DISTANCE software, we estimated the affect of these errors on density estimates. The implications of murrelet avoidance movement and birds missed near the transect line in obtaining unbiased estimates of density using the line transect method are discussed.

THE EFFECT OF NEST LOCATION ON BREEDING SUCCESS IN MARBLED MURRELETS: ESTIMATED COST OF NESTING FURTHER INLAND

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Radio transmitters were deployed on 24 Marbled Murrelets (*Brachyramphus marmoratus*) to locate nest sites in Desolation Sound, British Columbia, during the 1998 breeding season. Radio-tracking from a helicopter was used to locate nests, and tracking from the air and water was used to determine attendance patterns of birds, as an indication of breeding. Activity patterns confirmed incubation at 16 nests, and at 12, chick rearing. Inspection of some nests at the end of the breeding season indicated a minimum of three chicks fledged. At three other nests the egg was predated and at another, the chick died. The fate of 11 nests was unknown. Mean elevation of nests was 920 ± 392 m, aspect of $162.2 \pm 116.5^\circ$, with all nests within 50 km of presumed foraging areas. Presumed foraging areas were determined by the density of murrelet locations on the water, derived from radio tracking. A logistic regression was performed on the explanatory variables elevation, aspect and distance from presumed foraging areas to determine their relationship with breeding success. The flight speed of murrelets was calculated from radar and these, along with aspect ratios, were used to estimate the energetic cost of nesting varying distances from presumed foraging areas. The results are compared to other alcids.

SOME CONCEPTUAL IDEAS CONCERNING SEABIRDS AS INDICATORS OF CHANGING MARINE EN-

VIRONMENTS

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In Cairns' 1987 paper on seabirds as indicators of marine food supplies, he proposed that the shape of the curves depicting relationships between several demographic parameters of seabirds and the abundance of food were nonlinear. Since Cairns proposed these relationships, data from other studies have indicated that he was at least partly correct in that the relationship between breeding success and food supply is sigmoidal and that breeding success is unaffected by changes in food abundance at levels above a threshold. Here I propose parameters that affect the shape and position of the curve relating seabird breeding success to food supply. I make the following assumptions. There is a positive relationship between food supply and size of seabird colonies. When food becomes scarce, adult seabirds allow their chicks to die at the expense of keeping themselves alive. Adults remain at the colony whether or not they have chicks. Based on the energetic needs, I suggest that 1) the size of a colony determines the position of the curve in relation to food supply and, 2) the ratio of energy needs of chicks/energy needs of adults, determines the general slope of the curve and thereby varies among species. For example, everything else being equal, the position of the curve for a large colony will be to the right (higher food abundance) of a curve for small colonies (lower food abundance), and murrelets (small ratio) will have a greater slope than kittiwakes (large ratio). These predictions are testable and may help us to understand more about how seabirds indicate changes in the marine environment.

PENGUINS LIMIT FORAGING WHEN FORAGE IS LIMITING: NEW PERSPECTIVES ON STRATEGIES OF LONG-LIVED SEABIRDS

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A central hypothesis of seabird ecology predicts that parents will increase foraging effort to compensate for reductions in food supply, thus sustaining a constant level of provisioning for offspring. Studies apparently supporting this prediction have often used a species' reproductive performance to infer prey status, or have used prey data that are limited in spatio-temporal coverage and/or overlap with foragers. In contrast, theoretical considerations suggest that — under many ecologically realistic circumstances — parents of long-lived organisms should be expected to *decrease* parental effort in response to reduced prey. We related spatially and temporally relevant measures of prey density with at-sea behavioral data from chinstrap penguins collected over 8 years at Seal Island, Antarctica. Our findings were inconsistent with the hypothesis that parent birds increase foraging effort with declining resources; instead, penguins exhibited shorter diurnal foraging trips when conditions were less favorable. Overnight trips showed no patterns in relation to prey density, but trips spanning a day and night showed signs of a reversed pattern, i.e. trip duration decreased in good years. These trends more closely reflected adjustments in time spent actively foraging than changes in time spent traveling to or from foraging grounds. The close proximity of Seal Island to a relatively productive marine environment may afford penguins that nest there greater flexibility in foraging tactics relative to penguins that breed at less favorable sites.

EFFECTS OF SUPPLEMENTAL FEEDING LATE IN THE CHICK-REARING PERIOD ON PREFLEDGING MASS RECESSION

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Prefledging mass recession is exhibited by nestlings in many alcid species and there are several competing hypotheses regarding the reason for this phenomenon. I conducted a supplemental feeding experiment to explicitly test whether prefledging mass recession reflects a reduction or cessation of parental provisioning. All chicks were weighed daily from 30 days of age until fledging to examine growth patterns as the chicks approach

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fledging. Chicks in the experimental group were supplementally fed (50g her-ring) each morning from 40 days of age until fledging. If pre-fledging mass recession is caused by parental abandonment, chicks provisioned supplementally should show no pre-fledging mass recession. Additionally, if the nestling departure decision involves anticipated future provisioning, supplemented chicks would be expected to fledge older than control chicks. However, if chicks are chronically overprovisioned and lose mass to optimize fledging mass or wingloading, supplemented chicks should exhibit the characteristic pre-fledging mass recession accompanied by rejection of supplemented food. The data demonstrate that pre-fledging mass recession is a consequence of reduced parental provisioning and that chicks decide when to leave the burrow based, in part, on their preceding growth rate.

MARBLED MURRELET DAYTIME CHICK FEEDING BEHAVIOURS SUGGEST REVISITING PROTOCOLS

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The Caren Range on British Columbia's Sunshine Coast yielded Canada's first active Marbled Murrelet nest in 1993. Out of 101 chick feedings of this species monitored by the author and a small group of researchers representing Friends of Caren at two separate nest sites and three nestings during 1993, 1994 and 1997, 65 feedings took place after sunrise, one as late as 12:07 hrs. (Pacific Daylight Time). Of those observed after sunrise, 21 feedings took place before 7am, 24 between 7am and 9am, and 20 between 9am and 12:30pm (PDT). These findings suggest that Marbled Murrelets spend much of their time during the breeding season flying to and from the forests where they breed in broad daylight, contrary to the popular belief about the crepuscular nature of this species. Most of the flights to and from nests were direct, with no circling flights observed within 500 metres of the nests. These findings suggest that PSG protocols pertaining to inland behaviours should be revisited and revised, at least for Canada, and possibly for the entire range of this species.

FUNCTIONAL ADAPTATIONS FOR UNDERWATER ACTIVITY IN BIRDS

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Once birds approach their depth of neutral buoyancy (>10 m in auks but <1 m in cormorants), they may use either agility or speed or both depending on their structural adaptations. There are two types of body used by diving birds. Foot-propelled divers must maintain two large muscle masses, one for flight and one for swimming but reduce drag, which is proportional to cross-sectional area, by placing these masses in line. The long flexible neck compensates for the poor agility of this arrangement. Wing-propelled divers need only one large muscle mass and the central location of the wings gives the birds great agility. The stubby lateral profile created by crooking the neck and having a very short tail, reduces drag in tight turns. The partially-folded wing which many birds use for wing-propelled diving may be interpreted in terms of the integrated functioning of its parts underwater. In spite of its unlikely shape and numerous joints, the wing has compensating features which help stiffen it, reduce torsion in the joints, and make it a robust and useful paddle: the head of the humerus is flattened to fit into the slot-like shoulder joint; the elbow is in the center of the wing and braced by unusually robust secondary coverts above and below; and the folded primaries are braced at their mid-point by the tips of the secondaries to reduce torsion at the shoulder. In auks, an elongated humerus increases moment about the shoulder. The greater travel of the elbow generates speed underwater while shearwaters, which dive to similar depths, depend entirely on agility underwater. Shearwaters appear to lack specialized structural modifications for underwater activity.

EFFECTS OF WIND ON THE GROWTH RATE OF KITTIWAKE CHICKS

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Potential effects of wet, windy conditions on breeding seabirds are particularly severe for cliff-nesting, surfacing-feeding species such as Kittiwakes. I studied the effects of wind on growth rates of

Red-legged (*Rissa brevirostris*) and Black-legged (*R. tridactyla*) kittiwake chicks at St. George Island (southeastern Bering Sea) in 1993 and 1994. I weighed chicks every 3 - 5 days and compared mass increments (g/day) of each chick between time intervals with "windy" (wind > 25 km/h was sustained for more than 25% of interval) vs. "calm" conditions in paired-sample analyses. I used a two factor ANOVA to evaluate effects of nest exposure and species on the response of chick growth to wind, and found significant effects of both factors in both years. Strong winds suppressed growth rates of chicks exposed to severe updraft conditions at high-elevation sites relative to those of chicks located in less-exposed nests at lower elevations, an effect that was likely due to greater energetic demands of thermoregulation for chicks in exposed nests. In addition, windy weather also suppressed growth rates of Black-legged vs. Red-legged kittiwake chicks: the growth rate of Red-legged kittiwake chicks in sheltered nest sites was enhanced during windy weather while that of Black-legged kittiwakes was somewhat diminished. I speculate that the differing response of the two species is a consequence of differing effects of wind on flight energetics or foraging efficiency of adults which ultimately affect chick provisioning and growth rate.

MOVEMENTS OF AMERICAN WHITE PELICANS BANDED AT MARSH LAKE, MN

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We analyzed 625 recovery records for American White Pelicans (*Pelecanus erythrorhynchos*) banded at Marsh Lake, MN between 1972 and 1996 to determine migration and dispersal patterns. Recoveries included 542 dead birds, 39 birds that were subsequently released, and 44 birds of unknown fate. Median age at recovery was 1.0 year. The longest distance between banding and recovery was approximately 3200 km. Pelicans from Marsh Lake migrated through the Great

Plains and along the Mississippi River. Most birds spent the winter south of latitude 35° N in the lower Mississippi River Valley and the states and countries bordering the Gulf of Mexico. Between November and March, only 53 (9%) of 567 recoveries with accurate dates were retrieved above this latitude. Two-hundred and ten bands (34% of the total) were recovered south of latitude 35° N: 127 (60.5%) in the United States, 74 (35.2%) in Mexico, 6 (2.9%) in Guatemala, 1 (0.5%) in Honduras, 1 (0.5%) in Nicaragua, and 1 (0.5%) in Cuba. The effect of southeastern aquaculture on the winter distribution of pelicans will be discussed.

CONSEQUENCES OF VARIABILITY IN PREY ABUNDANCE AND PREY ENERGY CONTENT FOR BREEDING PIGEON GUILLEMOTS

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During 1995-1998 we measured forage fish abundance and Pigeon Guillemot (*Cepphus columba*) chick diet composition, provisioning rates, and chick growth rates in Kachemak Bay, Alaska. Pacific sand lance (*Ammodytes hexapterus*) comprised the majority of diets at some guillemot colonies, and we used our data to examine the possible advantages and disadvantages that a diet rich in sand lance would convey to breeding guillemots. We hypothesized (1) that the high caloric value of sand lance would translate to higher growth rates and/or reduced parental effort during provisioning; and (2) that temporal fluctuations in sand lance abundance would far exceed those of benthic fish, yielding greater variability in chick growth rates. Our data supported the first hypothesis; growth rates were positively correlated with the proportion of sand lance in the diet, and a diet rich in sand lance allowed parents to increase provisioning rates (kJ / h) without increasing delivery rates (meals / h). The second hypothesis was not supported. Although sand lance abundance varied about 40-fold among years, and benthic

fish abundance varied about 4-fold, we found no significant inter-annual differences in growth rates. Guillemots feeding on sand lance were able to buffer against low sand lance abundance by switching to benthic fish.

USING MULTIPLE METHODS TO DERIVE THE BREEDING PHENOLOGY OF MARBLED MURRELETS IN DESOLATION SOUND

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We used a combination of methods to derive the breeding phenology of a Marbled Murrelet (*Brachyramphus marmoratus*) population in British Columbia based on a three-year data set (1996-1998), and we assess the biases of each of them. The information previously used to derive the breeding chronology of Marbled Murrelets produced scattered data points allowing researchers to obtain only a range of possible breeding dates. We use some of the traditional methods and introduce three new methods that produce frequency distribution data of breeding events 1) juvenile counts from at sea surveys corrected for turnover, 2) physiological analyses of a yolk precursor from blood samples of captured birds, and 3) telemetry monitoring of breeding birds. We found the murrelet breeding season for British Columbia to be longer than what previous studies have shown, starting as early as April 13 and continuing until as late as September 15. The frequency distribution data allowed us to estimate periods when most of the birds would be incubating or chick rearing, and the data shows that these periods are concentrated in a narrow window compared to the range of possible breeding dates.

STAND AND LANDSCAPE FACTORS AFFECTING EDGE RELATED PREDATION ON MARBLED MURRELET NESTS

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We conducted artificial nest studies on the Olympic Peninsula of Washington (1995 to 1998) and in the Coast Range of Oregon (1997 and 1998) to assess the influences of stand and landscape level variables on edge related nest predation on Marbled Murrelets. We measured nest predation rates up to 300 meters from edge in stands of varying structure, adjacent matrix composition and levels of fragmentation at both the stand and landscape scales. Our results indicate that edge related predation effects in western forests are highly dependent on the surrounding matrix and diversity of the predator community. Edge effects are most likely to occur when the matrix contains habitat and foods used by predators. In our study area these conditions are met when mature forest fragments abut (1) clearcuts with berry crops and (2) human use areas (small towns and campgrounds).

RE-USE OF NEST TREES BY MARBLED MURRELETS

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Re-use of nest trees has important implications for our understanding of the demography and habitat use of Marbled Murrelets. Relatively little is known about the frequency of nest re-use by murrelets either within, between or over multiple years. I determined re-use of nest trees by Marbled Murrelets in the Bunster Range, located in south-western B.C. Re-use was determined using dawn surveys followed by tree climbing for 52 nest trees from 1996-1998. On average 12% of nest trees were re-used during the study. Nest trees were re-used within a breeding season (n=2) and between years (n=8). Re-use of the same nest site, and of different nest sites within a tree were observed. Most re-use occurred at failed nests. Murrelets attended nest trees prior to re-use both within a year and between years. The presence of multiple nest sites within a tree is additional evidence that a tree has been re-used. Twenty percent of the nest

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trees in this study had 2 to 3 nest sites. Individual birds were not identified during the study. Therefore, re-use of trees may represent breeding site fidelity by the same individuals or use of the same tree by different birds. I discuss the implications of re-use for the conservation and habitat management of Marbled Murrelets.

HABITAT CHARACTERISTICS ASSOCIATED WITH NEST SUCCESS AND PREDATION AT MARBLED MURRELET TREE NESTS

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Marbled Murrelets (*Brachyramphus marmoratus*) are unique among alcids in North America in their use of coastal older-aged coniferous forests for nesting. Despite being cryptic, secretive and primarily crepuscular at nests, they are vulnerable to high predation rates at their tree nests. Most active nests have failed (>65%) and the majority of these were unsuccessful because of predation (>60%). To determine if habitat characteristics influence nesting success, we compared nest site, nest tree and within-stand characteristics of successful and unsuccessful nests. A sample of nests with known outcomes (successful, failed) from Alaska (n=9), British Columbia (n=34), Washington (n=4), Oregon (n=20) and California (n=10) were used in the analysis. We found that successful nests were further from the stand edge and were closer to the trunk than unsuccessful nests. Survival rates within 50 m of an edge were only 38%, whereas nests >50 m from the edge had a 62% survival rate. Nests located within 0.5 m of the tree trunk were more successful (71%). In addition to nest characteristics and known predators of chicks, eggs and adults at nests, we discuss the implications of nest success to the population status and habitat management of Marbled Murrelets.

DIVERSE COMMUNITIES OF NEST PREDATORS: IMPLICATIONS FOR MURRELET BREEDING SUCCESS

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Our studies (1995-1998) at simulated Marbled Murrelet nests in Washington and Oregon have identified a diverse array of potential nest predators. Predators differ in being (1) nocturnal or diurnal, (2) avian or mammalian, and (3) most common in murrelet nesting habitat or the surrounding matrix. The implications of a diverse predator community include (1) high overall rate of predation (eggs and chicks are vulnerable during day and night), (2) selection for nest/chick concealment and chick/adult defensive ability, (3) complex association between nest vulnerability and characteristics of the nest stand and surrounding landscape, and (4) complex relationships between the rate of predation and distance of the nest from the forest edge. We discuss how understanding these complexities can affect our management of murrelet nesting habitat. Our results and a review of the nest predation literature suggest that thorough understanding of the nest predators is rare and this reduces our ability to accurately manage nesting habitat.

STELLER'S JAY ECOLOGY IN FRAGMENTED FORESTS OF COASTAL BC, WITH IMPLICATIONS FOR MARBLED MURRELETS

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Steller's Jays (*Cyanocitta stelleri*) eat eggs and chicks of the threatened tree-nesting Marbled Murrelet (*Brachyramphus marmoratus*). Timber harvesting negatively impacts murrelet numbers through forest fragmentation and reduction of old-growth nesting habitat, but may benefit jay populations due to an increase in edge habitat. Information on Steller's Jay ecology is limited therefore I implemented a two-year study (summers 1996-97) to investigate the abundance, distribution, and habitat use of Steller's Jays in fragmented landscapes. The study, located on the southwest coast of Van-

couver Island, consisted of three widely separated study sites. At each site, paired 1 km transects (4-5 point count stations per transect), were used to census the relative abundance of jays in two habitat types (forest and edge) and in three location types (road, clear-cut and river). An analysis of variance was performed to test for variation in jay abundance among habitats, locations and sites. Point counts indicate that jay abundance was greatest along clear-cut edges and was significantly higher at edges than interior forest habitat for all location types. Telemetry and focal point observations were used to compare home-range size and fine scale habitat use of two jay groups; those that used clear-cuts (n=6) and those that did not (n=5). Home-range estimates were variable (95% minimum convex polygon, 3.70-50.01 ha.). There was no difference in home-range size or patterns of habitat use between the two jay groups. My data show that murrelet nests located near roads and clear-cuts, are at greater risk to predation by jays.

STATUS AND DISTRIBUTION OF THE ASHY STORM-PETREL ON THE CALIFORNIA CHANNEL ISLANDS, 1991-1997

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We conducted surveys of Ashy Storm-Petrel (*Oceanodroma homochroa*) colonies on the California Channel Islands in 1991-1997. Among the rarest North Pacific seabirds, this secretive species nests primarily in rock crevices in small to medium-sized colonies off the coasts of central and southern California. In 1975-1977, about 600 pairs, or 23% of the known world population, were estimated breeding at eight Channel Islands' colonies. In this study, we resurveyed known and searched for new colonies using nest searches and mist-netting to provide updated information. We confirmed breeding at 16 colonies, including nine newly-

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discovered colonies, and suspected breeding at eight others. The largest colonies occurred off San Miguel Island (at Prince Island and Castle Rock) and at Santa Barbara Island. Several new colonies at Santa Cruz Island were in previously unexamined habitats within sea caves. Nesting was confirmed for the first time at San Clemente Island. At Santa Catalina Island, nesting was suspected where breeding has not been documented since 1937. Small numbers of mist-netted birds at Anacapa Island indicated probable breeding but introduced rats may limit population size. We estimate the Channel Islands' population comprises 50-65% of the known world population. However, higher recent estimates are largely due to methodological differences and increased survey effort.

MARbled MURRELET USE OF LANDSCAPES FOR NESTING IN CALIFORNIA AND SOUTHERN OREGON

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We evaluated marbled murrelet (*Brachyramphus marmoratus*) use of landscapes and the juxtaposition of forest nesting habitat to marine habitat in a study area that extended from Coos Bay, Oregon to Monterey Bay, California. Using GIS and Landsat-derived coverages, fragmentation indices of patches of vegetation classified by seral stage were calculated within circular plots of 400-m, 800-m, 1600-m, and 3200-m radius. Plots were centered on occupied and unoccupied sites within surveyed stands. We measured distance to nearest marine features, roads, and streams, and recorded topographic and climatic variables from plot centers. Using logistic regression, we found sites occupied by nesting murrelets were closer to major bays and marine areas with high summer primary productivity and were at lower elevations. These sites were in patches having at least 10% of trees in old-growth forest, where the patches were mostly restricted to the redwood vegetation zone in California and the moist coastal Douglas-fir-dominated zone in Oregon. Occupied plots contained more old-growth forest that had complex edge, interior habitat, and nearby mature

second-growth forest. They contained fewer patches of young hardwoods and had less complex edge across the landscape. Probability of occupancy increased if a plot was within 5 km of another plot where murrelets were detected.

SOURCES OF INTRACLUTCH EGG-SIZE VARIATION IN THE COMMON TERN

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In species that exhibit brood-size adjustment, last-laid eggs are assumed to be relatively small to facilitate brood reduction. Alternatively, intr clutch egg-size variation (ICESV) may be a function of ambient temperature during clutch formation. We examined the pattern of ICESV in Common Terns breeding near Hamilton, Ontario over 5 years (1992, 94-97). Both the size of eggs laid and the pattern of ICESV varied across years. In 1992, eggs were relatively large with the second-laid egg being largest. In 1994, eggs were relatively small and the last-laid egg was disproportionately smaller than the rest of the clutch. In other years, egg size decreased linearly with laying order. The period prior to egg-laying was mildest in 1992, conditions were moderate in 1994, while the other years were colder, windier and wetter. Within years, weather during the period of clutch formation was related to egg size: larger eggs were produced when conditions were warmer and calmer/drier. Environmental conditions during egg formation may affect egg size by (1) directly affecting female metabolic costs, (2) affecting foraging conditions and therefore the availability of resources for egg formation, and (3) by serving as a predictor of conditions during chick-rearing, information which females use to optimize the size of the eggs they lay. Our data suggest that all three mechanisms may be influencing egg-size variation in this species.

EXPERIMENTAL RELEASE OF OIL-SPILL REHABILITATED AMERICAN COOTS (*FULICA AMERICANA*): EFFECTS ON HEALTH AND BLOOD PARAMETERS

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The Unocal-Metrolink oil spill of February 21, 1995 resulted in approximately 7800 barrels of San Joaquin crude oil being deposited into the San Gabriel River in Huntington Beach, CA. In order to determine long-term pathological effects of oil exposure and rehabilitation, hematological and serum biochemical parameters for both rehabilitated (RHB) American coots (*Fulica americana*) and reference (REF) coots were examined every 3-4 weeks (56d, 81d, 108d and 140d post oil exposure) after birds were cleaned, rehabilitated and released. Most significant differences in monthly comparisons between RHB and REF birds occurred within 56 days of oil exposure. Total white blood cell count (WBC), albumin:globulin (A:G) ratio and calcium concentration were higher in RHB birds compared to REF birds 56d post oil exposure. In addition, mean cell hemoglobin (MCH), mean cell hemoglobin concentration (MCHC), alkaline phosphatase (Alk Phos), alanine aminotransferase (ALT), aspartate aminotransferase (AST) and creatine kinase (CK) activities; and creatinine, total protein (TP) and globulin concentrations were lower in RHB birds.

Blood results from 56d post oil exposure for RHB coots which subsequently died were compared to blood results from days 108 and 140 for REF coots which survived. Oiled and rehabilitated birds which died had significantly higher WBC, packed cell volume, TP and globulin concentrations; and lower A:G ratio, MCH, MCHC, glucose and Na concentrations compared to REF birds which survived.

Blood result differences detected at 3-4 week intervals between RHB and REF survivors, and differences detected be-

tween RHB coots which died and REF coots which survived, suggested that RHB coots developed an inflammatory response (infectious or non-septic), and concurrently, may have experienced decreased immune responsiveness. Additionally, RHB coots experienced either an iron utilization or iron metabolism problem. These pathophysiologic mechanisms were consistent with increased hemosiderin (stored iron) was present in the liver, spleen and kidney of necropsied RHB birds, and may have contributed to RHB coot mortality.

When blood parameter differences were examined for their impact on survival time, it was determined that RHB coots had shorter survival times if they had very high cholesterol (\bullet 449 mg/dl) or Cl (\bullet 110 MEQ/L) concentrations on day 56 post oil exposure. Interestingly, the lack of differences between RHB and REF coots from day 81 through day 140 suggested that, from a hematologic and clinical chemistry perspective, coots which were oiled, rehabilitated, released and survived at least 3.5 months could not be differentiated from wild (REF) coots. From these findings it appears that blood analysis, coupled with post-release survival data, may help discern reasons for increased mortality of oiled and rehabilitated birds, compared to non-oiled reference birds.

FORAGING AND MORPHOLOGICAL DIFFERENCES BETWEEN KITTLITZ'S AND MARBLED MURRELETS

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We studied foraging ecology and its relationship to morphology in two closely related species, Kittlitz's (*Brachyramphus brevirostris*) and Marbled (*B. marmoratus*) murrelets, because casual field observations suggested that the two species exhibited segregation in foraging habitat and that these differences appeared to be accompanied by morphological differences in eye size. In Prince William Sound, Alaska, the two species differed significantly in preferred habitat type and mean secchi depth (an indicator of water clarity). Mean secchi depth was lowest in glacial-affected and glacial-stream-affected waters, which were preferred for foraging by Kittlitz's Murrelets, and was

highest in marine-sill-affected and glacial-affected waters, which were preferred by Marbled Murrelets. Although feeding frequency in glacial-affected habitats did not differ between the two species, very few Marbled Murrelets occurred in this habitat, whereas the highest densities of Kittlitz's Murrelets occurred there. We examined eye morphometrics from a sample of museum specimens in an attempt to explain this ecological differentiation. Mean proportions of total skull length and of total post-bill skull length occupied by the orbit diameter were significantly greater in Kittlitz's Murrelets than in Marbled murrelets. These results suggest ecological differentiation in use of foraging habitat by the two species, with Kittlitz's Murrelets adapted to foraging in highly turbid water near glaciers and Marbled Murrelets adapted to foraging in clearer water away from glaciers. These differences in foraging habitat and water clarity probably have led to the differences in relative eye size between the two species.

METAPOPULATION AND GENETIC STRUCTURE OF ASHY STORM-PETRELS, *OCEANODROMA HOMOPHROA*: A POPULATION VIABILITY ANALYSIS

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The Ashy Storm Petrel is a rare species (10,000 or fewer breeding individuals, world-wide), whose breeding is confined to islands off the Central and Southern California coasts. To help design conservation and management plans for this federally-designated Species of Concern, we carried out a population viability analysis (PVA) of this species. The PVA assumed individual subpopulations linked by restricted dispersal, i.e., a metapopulation. Genetic information for the model was obtained by analyses of mitochondrial DNA cytochrome b and control region. These results indicated that populations on Southeast Farallon Island and Santa Barbara Island are not genetically distinct and are likely of recent origin (6,000 years or less). It was not possible

to estimate current rates of gene flow between the two populations; the data are consistent with low dispersal rates among populations. The PVA incorporates environmental and demographic stochasticity as well as available information on survival of adults and immatures, reproductive success, and age of first breeding. We use the PVA to project future population trends under different scenarios (e.g., change in management, change in the environment) and to evaluate sensitivity of results to small changes in the various demographic parameters (including survival, reproductive success, and dispersal). We also estimate probability of extinction in the next 100 years, as a basis for considering whether the Ashy Storm Petrel should be designated a Threatened species.

THE EFFECT OF AGE AND GENDER ON THE ADRENOCORTICAL RESPONSE TO STRESS IN LEACH'S STORM-PETRELS

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We examined the adrenocortical response to capture and handling stress in a breeding population of Leach's Storm-petrels (*Oceanodroma leucorhoa*) at Kent Island, New Brunswick in 1996 and 1998. Acute elevation of corticosterone has been associated with gluconeogenesis, increased feeding behavior, and "escape" behavior. However, chronic elevation of corticosterone inhibits reproductive behavior and immune function. Because an elevated stress response may enhance survival at the expense of reproduction, we expected younger birds to have a higher stress response than older birds. The stress response, as measured by the increase in plasma levels of corticosterone between 3 and 30 min after capture, was negatively correlated with age in 1996 ($p < 0.01$, $n=70$) and in 1998 ($p < 0.01$, $n=198$). Baseline levels of corticosterone (obtained within 3 min of capture) were positively correlated with age in both years ($p < 0.01$). The magnitude of the stress response was also negatively correlated with the number of times individuals had been handled by researchers ($p < 0.01$ in 1996 and 1998). Males and females had similar levels of corticoster-

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one in response to capture stress, as predicted since both sexes have equal and obligate parental care. Testosterone levels were elevated at the beginning of incubation, but decreased as the breeding season progressed (females: $p < 0.05$; males: $p = 0.05$). Males had significantly higher testosterone levels than females during incubation ($p < 0.05$).

MARBLED MURRELETS AS INITIATORS OF FEEDING FLOCKS IN PRINCE WILLIAM SOUND, ALASKA

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I sought to determine which seabird species initiated small, ephemeral, multispecies feeding flocks in Prince William Sound, AK (PWS), by observing the formation of flocks at sites known to have frequent feeding aggregations. I observed 43 feeding flocks at 5 sites during June 1996 and determined the initiating species at 34. All of the observed flocks were initiated by pursuit divers, of which 76.5 % were Marbled Murrelets (*Brachyramphus marmoratus*), the most abundant seabird in PWS. Formation of feeding flocks followed either of 2 scenarios: 1) larids were attracted to a feeding location by the presence or activity of Marbled Murrelets or 2) both larids and murrelets were present and flock feeding began after the murrelets dove from the surface. Of the observed flocks, 26.9 % and 50.0 % were initiated under scenarios 1 and 2, respectively. Other principle participants were Black-legged Kittiwakes (*Rissa tridactyla*) and Glaucous-winged Gulls (*Larus glaucescens*). I observed an apparent commensal relationship between murrelets and larids at feeding flocks with larids being the beneficiary.

IMPACTS OF AVIAN PREDATION ON FISHERIES AND RECOVERY OF ESA LISTED SALMON IN THE COLUMBIA RIVER BASIN

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Colonies of Caspian terns and double-crested cormorants nesting on man-made islands in the Columbia River Estuary have expanded rapidly in the past 15

years. Caspian terns that first nested in the estuary in 1984 now number 10,000 pairs. Cormorant colonies have increased from a few hundred pairs to 7,000 pairs in the same period. Concurrently, many salmon populations have become listed under the Endangered Species Act. A research project on avian predation impacts estimates up to 30 million juvenile salmon smolts are consumed annually by the bird colonies. The smolts consumed by birds represent up to 400,000 lost adult returns worth many millions of dollars to tribal, recreational and commercial fisheries. Evidence is presented that up to 3 million of the smolts lost to predation are listed under the ESA and represent 30,000 adults that will not return to spawn. Although there are other factors in the decline of anadromous fish

of the Columbia Basin, avian predation may be the most serious problem for some listed stocks.

CORRELATING FOREST HABITAT DISTRIBUTION WITH MURRELET RADAR COUNTS: IS THERE A CONNECTION AT THE DRAINAGE SCALE?

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The amount, configuration, and availability of suitable nesting habitat has been proposed to influence the number and distribution of marbled murrelets (*Brachyramphus marmoratus*) during the breeding season. Long-term monitoring of this threatened species likely will occur on a broad scale, and reliable methods to track changes in murrelet populations and habitat need to be developed. We tested whether the amount of potential nesting habitat within drainage predicts numbers of murrelets entering that drainage. Using radar, we estimated murrelet numbers in 9 river drainages on the Olympic Peninsula, Washington, during late June and July 1998. Each site was sampled 2-3 consecutive days. Total area of drainages ranged 14,600 to 75,700 ha, and included 30-60% of late-seral habitat as classified from satellite imagery. We compared the mean count of inland-bound murrelet targets to the amount of late-seral habitat within drainage boundaries. Number of

murrelets detected with radar generally was positively but weakly associated with the amount of late-seral habitat within the drainage. We discuss the implications of these findings to long-term monitoring strategies and we propose improvements in study design that might lead to more robust conclusions.

SAND LANCE: HOW THEIR BIOLOGY IMPACTS PREDATORS AND RESEARCHERS

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Sand lance (*Ammodytes hexapterus*) are an important forage fish for many Gulf of Alaska and Bering Sea predators. Significant biological changes have occurred in this area as a result of climate change since the late 1970s. However, the unique biology of sand lance has allowed their abundance, and hence availability to predators to remain relatively stable. Fat reserves of adults are established during spring plankton blooms. Correspondingly, energetic value increases over 30% by July, allowing chick-rearing seabirds to utilize peak condition sand lance of about 21kJg⁻¹ (dry). Subsequently, they remain buried for increasing periods in shallow substrates, as energy reserves are utilized for maturation and spawning in October. Consequently, sand lance represent a relatively low-value winter prey source compared to other forage fish which maximize energetic value in winter such as capelin (*Mallotus villosus*). Juvenile sand lance recruit to nearshore areas in May, and become the dominant taxa by late August. Somatic growth is rapid, followed by increases in energetic value, which peak at 20kJg⁻¹ (dry) in September. Therefore, juveniles may provide an abundant and energetically rewarding pre-winter prey source for predators. Back-calculations of sand lance size from otoliths need to consider that single regressions are rarely adequate in describing the otolith/fish length relationship. Sand lance exist in distinct populations, which live, spawn, and develop in conjunction with specific nearshore substrates, making them highly vulnerable to habitat degradation (e.g., oil or physical disruption).

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WHAT TO DO WITH THE WORLD'S LARGEST CASPIAN TERN COLONY: WHEN ESA COLLIDES WITH MBTA AND NEPA IN THE COLUMBIA RIVER ESTUARY

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Caspian tern predation rates on juvenile salmonids in the Columbia River estuary are astonishingly high. In both 1997 and 1998, estimates of the number of salmon smolts consumed by terns nesting on Rice Island (an artificial dredge disposal island) were 6-27 million, or 5-25% of all out-migrating salmonids that reached the estuary. Most Columbia Basin salmonid stocks are ESA-listed, but terns eat mostly hatchery-raised smolts. Caspian terns first nested in the Columbia River estuary in 1984; in 1998 the Rice Island colony numbered over 20,000 individuals, apparently the largest colony of its kind in the world. The colony coalesced from former colonies and now represents over 75% of all Caspian terns breeding along the Pacific Coast, and 25-30% of the North American population. The magnitude of smolt losses to Caspian terns in the Columbia River estuary results from (1) availability of nesting habitat on dredge spoil islands, (2) abundant and readily-captured prey, (3) loss of tern nesting habitat elsewhere due to human activities, and (4) declines in alternative fish prey. Redistribution of the Rice Island Caspian tern colony to a number of former and new breeding sites may benefit both terns and salmonids alike.

ADVECTIVE CONTROL OF ANT-ARCTIC KRILL-BASED FOOD WEBS

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The factors underlying extreme fluctuations in krill distribution and abundance, and their consequent impacts on krill predators, have become an important focus of Antarctic marine ecology. Using a time series of bottom pressure anomalies from the continental slope north of the Antarctic Peninsula, we demonstrate that interannual fluctuations in krill abundance in the Elephant Island region are significantly related to an index of potential advective input of krill to the region via passive transport in currents. Results from a 6-year study of Chinstrap Penguins (*Pygoscelis antarctica*) — the principal krill predators in the Elephant Island region — suggest that 1) breeding population size and reproductive performance were affected by variation in advection of prey to their summer foraging grounds during the spring pulse of the Antarctic Circumpolar Current (ACC), and 2) the early-season condition of breeding penguins was affected by the extent to which their winter foraging grounds were replenished with advected krill during the preceding autumn ACC pulse. These findings support a prominent role for oceanic advection in Antarctic krill-based food webs.

CONTRASTING PATTERNS OF REPRODUCTIVE SUCCESS FOR TUFTED PUFFINS AND RHINOCEROS AUKLETS IN BRITISH COLUMBIA: 1975-1998

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Should two closely related alcids respond to long term changes in the marine environment in a similar manner? To address this question we compared nestling growth, productivity and diet for the diurnally active Tufted Puffin and the nocturnally active Rhinoceros Auklet breeding on Triangle Island, B.C. using current and historical data. Both species exhibit a decline in breeding success from 1975-1998, and values for TUPU have been consistently lower than for RHAU. TUPU have virtually failed to produce any fledglings from 1994-1998. In addition, chick growth rates of both species have declined since the 1970s. Concurrently, there has been an overall decline in the proportion

of Sand lance in the diet of nestlings of both species. During the 1990s Sand lance consistently disappeared from the RHAU nestling diet from mid to late July in each year. In the absence of Sand lance, RHAU switched to alternative prey species such as Pacific Saury, Pacific Herring, Salmonids and Rockfishes. In contrast, TUPU did not exploit the same range of alternative prey and breeding failure thus coincided with the timing of absence of Sand lance from nestling diets. TUPU may be unable or unwilling to provision their chicks with alternative prey species of sufficient quantity or quality when Sand lance appear unavailable. We postulate that the interspecific differences in nestling diet and breeding success may reflect foraging constraints imposed by the diurnal provisioning habits of the TUPU which do not affect the nocturnal RHAU.

INTERANNUAL VARIABILITY IN THE REPRODUCTIVE SUCCESS OF PIGEON GUILLEMOTS NESTING ON JACKPOT ISLAND, IN SOUTHWESTERN PRINCE WILLIAM SOUND, ALASKA, 1994-1998.

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Since the 1989 Exxon Valdez oil spill (EVOS), the population of pigeon guillemots, *Cepphus columba*, in Prince William Sound, Alaska, have shown no growth. We studied the breeding biology and nestling diet of pigeon guillemots at Jackpot Island, from 1994 to 1998, to examine factors that may be limiting population growth at colonies not directly oiled by EVOS. Between 1993 and 1998, the Jackpot Island colony increased from 79 birds to 101 birds. Annual productivity from 1994 to 1998 was 0.61, 0.25, 0, 0.17, and 0.18 fledgling/egg, respectively. Nesting efforts failed in 1996 because of catastrophic mink predation on the island. In the other four years of our study, nest predation was low (6% of the nests). The

1994 breeding season was noted for having the lowest nest abandonment rate during incubation, 21%, the highest mean growth rate of nestlings aged 8-18 days, 20.3 ± 3.5 g/day, and highest mean fledge (± 2 days) mass, 508 ± 37 g, during our five year study. Nest abandonment rates, mean (\pm SD) growth rate and mean (\pm SD) fledgling mass, respectively, were 34%, 17.1 ± 2.8 g/day, 467 ± 39 g in 1995; 48%, 18.6 ± 7.0 g/day, 472 ± 41 g in 1997, and 61%, 18.8 ± 3.4 g/day, 482 ± 42 g in 1998. Thus compared to 1994, lower productivity and higher nest abandonment in 1995, 1997 and 1998 were associated with lower growth rates and lower fledge weights. These associations suggest that higher rates of nest abandonment in 1995, 1997, and 1998 may have been caused by food limitation during the incubation period as reflected by the subsequent decline in growth rates and fledge weights of surviving nestlings in those years.

ASSESSING POPULATION STATUS AND MONITORING REPRODUCTIVE SUCCESS OF THE CHRISTMAS SHEARWATER (*PUFFINUS NATIVITATUS*) ON EASTERN ISLAND, MIDWAY ATOLL NWR

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The Christmas Shearwater (*Puffinus nativitatis*) can be found in small populations scattered throughout the Central Pacific Ocean, including Midway Atoll NWR, Northwestern Hawaiian Islands. Black rats were introduced to Midway Atoll in 1943. After its introduction, nesting populations of several ground-nesting Procellariiformes declined rapidly or were extirpated. The population size of the Christmas Shearwater and impact of rat predation had never been assessed prior to 1995. In 1994, rats were eradicated from Eastern Island. In 1995, a three year study was initiated on Eastern Island to assess the population status and monitor the reproductive success of the Christmas Shearwater after rat eradication. This study involved repeated searches in historical nesting areas under dense *Scaevola sericea* bushes, a succulent shrub commonly found on coastal islands in the Pacific. Results indicated a surprisingly higher breeding population

than estimated in the past. In 1995, a total of 99 active nests were monitored with 69% hatching success, 87% fledging success, and 60% reproductive success. After discovering the high number of nests in 1995, the study was intensified to search the entire island for nesting birds. In 1996, a total of 179 nests were monitored with 53% hatching success, 79% fledging success, and 41% reproductive success. In 1997, 194 nests were monitored with 78% hatching success, 79% fledging success and 62% reproductive success. A total of 695 breeding and non-breeding adults and 213 chicks were banded during the three year project.

USE OF RADAR TO MONITOR MARBLED MURRELETS IN THE SANTA CRUZ MOUNTAINS, CALIFORNIA

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A pilot study was conducted using ornithological radar to track and monitor Marbled Murrelets (*Brachyramphus marmoratus*) in four drainages in the Santa Cruz Mountains, California. The Santa Cruz Mountains are the southernmost murrelet breeding area and support the smallest and most isolated population of the Marbled Murrelet. Our primary monitoring site, Gazos Creek Canyon, is typical of coastal canyons in the Santa Cruz Mountains — steep and narrow with a dense cover of coast redwood, and separated from the coast by a marine terrace covered with grassland or chaparral. Although radar has been successfully used to detect murrelets in other terrains, this technique had not been used in the unique terrain found in the Santa Cruz Mountains. Through careful selection of station locations we were able to successfully use radar to monitor murrelets traveling to and from their breeding areas. Radar stations we used included grassy knolls at the mouth of forested canyons, canyon bottom meadows, hillside openings, and ridge top locations. We discuss the criteria for suitable radar survey sites and the parameters affecting the detection of murrelets by radar. We describe some new tools that maximize data from murrelet radar surveys and reduce identification errors. Our findings indicate that radar is

the ideal tool for locating murrelet breeding areas in the Santa Cruz Mountains and for monitoring changes in the number of murrelets using those areas over time.

MIGRATION ROUTES OF SOOTY SHEARWATERS IN THE PACIFIC OCEAN

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During 17 cruises, 1983 to 1991, we recorded flight directions and densities of Sooty Shearwaters (*Puffinus griseus*) migrating across the equatorial Pacific, between the Americas and 170° W. Sooty Shearwaters breed in New Zealand and Chile in boreal winter, migrate to the North Pacific during spring, and return south in autumn. A two-fold increase in numbers flying northwest from the Peru Current in spring compared to the number fly southeast on return in autumn, and six-fold increase in numbers flying southwest towards New Zealand during autumn, compared to the number migrating northeast during spring, indicates that many completed a figure-eight route (ca. 40,500 km) each year. This route would involve easterly flight from New Zealand to the Peru Current in winter, northwesterly flight to the western North Pacific in spring, eastward movement to the eastern North Pacific during summer, and southwest flight to New Zealand during autumn. We suggest that most shearwaters using this route are nonbreeders, possibly from both the New Zealand and Chilean populations. Many birds, probably breeders, likely use shorter routes to and from the North Pacific (ca. 28,000 to 29,000 km). A progressive annual increase in the number migrating to the North Pacific, concurrent with a progressive increase in sea-surface temperature, mostly reflected increased migration from the Peru Current. This also was consistent with a concurrent sharp decline of these birds in the California Current. These results indicate a distributional shift during the nonbreeding period, from the eastern boundary currents to the central North Pacific.

INDIRECT EFFECTS OF THE AVAILABILITY OF FORAGE FISHES AND FISHERIES DISCARDS: GULL PREDACTION ON BREEDING STORM-PETRELS

ABSTRACTS

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The Northwest Atlantic has undergone large-scale perturbations which have had profound effects on pelagic food webs. Over the past century, the availability of human refuse and discarded fisheries waste have supported and maintained the growth of Larid gull populations. Recently, cold surface-water events have delayed the inshore movements of forage fishes and fisheries closures have removed massive quantities of discards. These circumstances have interacted to generate intense food stress on gulls. We investigated the indirect effects of prey availability and fishing activities on seabird community interactions. Gull predation on Leach's storm-petrels (*Oceanodroma leucorhoa*) did not differ between forest and open habitats even though gull nests were more often in close proximity to storm-petrels in open areas than in forest habitat. In 1996 and 1997, gull predation on storm-petrels varied seasonally, with a significant decrease following the inshore movement of spawning capelin (*Mallotus villosus*) a primary food that gulls consume and feed to their chicks. Capelin availability was considerably later in 1997, when gull predation on storm-petrels was greater and prolonged. The intensity of gull predation on storm-petrels depends on the availability of alternative food sources.

THE PACIFIC SEABIRD MONITORING DATABASE — A DESKTOP INFORMATION SYSTEM FOR NORTH PACIFIC SEABIRDS

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A 1992 Pacific Seabird Group survey of past and present seabird monitoring efforts in the temperate North Pacific indicated that upwards of 10,000 observations on seabird population parameters are available for North Pacific colonies. The Pacific Seabird Monitoring Database was developed as a means of making these largely inaccessible data available to potential users in a timely manner. Since

1995, 13 contributors have entered into the database almost 1,900 series and a total 11,693 observations on 56 species that breed in the Pacific north of 20° N. Each observation represents a yearly estimate of a particular population parameter for a given species in a given location. Population size (40 percent of observations) is the most studied parameter included in the data set, followed by components of productivity (25 percent) and reproductive chronology (20 percent). Data exists for locations in Alaska (65 percent of observations), Oregon, Hawaii (16 percent), California (12 percent), British Columbia, and the Russian Far East. With 3,485 observations (30 percent) the black-legged kittiwake (*Rissa tridactyla*) is the single most studied species. The database utilizes a run-time version of Microsoft Access for data entry, editing, querying, reporting and exporting, and includes Geographic Information System databases to be used with ArcView 3.0 for regional database querying, mapping, and spatial analysis capabilities. A test version of the database on compact disk and an instruction manual have been released for peer review. Internet access to the database is anticipated in 1999. This project is a cooperative effort of the Pacific Seabird Group and the USGS-Biological Resources Division, Alaska Biological Science Center.

SEASONAL MIGRATION OF MAGELLANIC PENGUINS: EVIDENCE FROM BAND RETURNS

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Fourteen years of winter band return data for Magellanic penguins (*Spheniscus magellanicus*) indicate that this species may undertake one of the longest seasonal migrations known among non-flying birds, with a one-way distance often exceeding 2000 km. Chicks, juveniles, and adults banded at a breeding colony in southern Argentina were most commonly found in winter along the coasts of Uruguay and southern Brazil. Distance traveled appears to decrease somewhat with age, but even birds in the oldest age class studied (>3 years) were found more than 2000 km from the colony. The number of bands recovered from dead or moribund birds in the winter following fledging was inversely correlated with subsequent re-

sighting rates of live birds in each cohort at the colony, suggesting that mortality during the migration period is a significant determinant of recruitment rate. Survival rate and location of fledglings during migration varied by year, and is likely to be dependent on oceanographic conditions, although this relationship appears to be complex. The great distance of the seasonal migration and the fact that the migration route traverses the waters of three nations present a major challenge in the conservation of this species.

FORAGING ECOLOGY OF BLACK-LEGGED KITTIWAKES IN RELATION TO PREY ABUNDANCE

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We studied nestling diets and foraging activities of breeding Black-legged Kittiwakes during five years (1989-90 and 1995-97) of high to low food abundance at two colonies, Shoup Bay and Eleanor Island, in Prince William Sound, Alaska. Years of low food abundance were associated with increased foraging effort (duration, distance, and travel time) and significant changes in diet (prey switching). Foraging activities and flight paths of radio-tagged adult kittiwakes were recorded while following individuals by boat. Foraging effort was consistently greater at Shoup Bay ($P < 0.05$) with a mean trip duration of 4 hr and distance of 40 km in good food years, increasing to 6 hr and 60 km during a year of low food abundance. Foraging trips of kittiwakes at Eleanor Island averaged 2 hr and 5 km during years of high food abundance and increased to 5.6 hr and 35 km during the worst year. Years of low food abundance were associated with significant declines ($\chi^2 = 18.47$, $P = 0.001$) of age class one Pacific herring in kittiwake diets. Consequences of reduced herring were greatest at Shoup Bay where alternative prey close to the colony did not exist. Whereas kittiwakes from Eleanor Island compensated for lack of herring by obtaining Pacific sand lance and capelin. Time spent traveling increased with greater trip duration, but search and prey capture time were not directly related to trip duration and may reflect foraging strategies that vary with different species, age classes, or abundance of prey consumed.

ABSTRACTS

BASELINE MONITORING AND ASSESSMENT OF EFFECTS OF DISTURBANCE TO BRANDT'S CORMORANTS ON ALCATRAZ ISLAND, CALIFORNIA

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The Brandt's Cormorant colony on Southeast Farallon Island has experienced consistent decline since the 1970's, while in recent years, new colonies have been established at several locations along the California coast. Brandt's Cormorants began breeding on Alcatraz in 1993, creating the only colony for this species in San Francisco Bay. We monitored cormorants on Alcatraz during the breeding seasons from 1996-1998 to establish baseline information on distribution, abundance, productivity, and human-caused disturbances to this colony. Productivity averaged a relatively high 1.90 chicks/pair, despite a high rate of disturbance. Abundance and productivity were lower in 1998 than in previous years, due largely to El Niño effects. Nonetheless, Brandt's Cormorants still produced 1.53 chicks/pair in 1998, higher than the 25-year average for birds in the established, offshore Farallon Island population (1.35 chicks/pair). In 1997 and 1998, we looked at activity budgets and chick-feeding rates on Alcatraz, to begin to investigate this paradoxical high productivity in the face of considerable disturbance, as well as how cormorants' behavioral strategies may vary in El Niño years. Overall monitoring of Brandt's Cormorants on Alcatraz will continue in order to evaluate the long-term stability of the population. Our data, along with additional information on prey dependence, and similar information from other colonies, may help shed light on meta-population changes, especially the coastward movement of this species in central California.

BEHAVIOR OF MARBLED MURRELETS IN RESPONSE TO SURVEY VESSELS DURING AT-SEA SURVEYS: IMPLICATIONS FOR USE OF LINE TRANSECTS

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There is general consensus that Marbled Murrelets can be censused best at sea. In addition, there is growing consensus that line transect sampling is the best at-sea survey method for doing so. This method employs DISTANCE software that calculates corrected bird densities by estimating the percentage of birds that are not detected at various perpendicular distances from the transect line. However, the validity of line transect sampling rests on two assumptions: (1) that all birds are detected on or near the transect line, and (2) that birds do not move significantly away from the transect line prior to being detected. We tested these assumptions on boats of three different size-classes ranging in size from 19 to 44 feet. Few significant differences were detected among boat classes. About 10-15% of murrelets were missed on or near (• 40M) the transect line. In addition, murrelets moved an average of 2-5 M away from the transect line prior to detection. The rate of movement away from the transect line was not related to the distance in front of the boat at which they were detected. In addition, murrelets were detected at an average distance of 59 M in front of survey vessels, but did not fly or dive in response to survey vessels until they were much closer to them; these results suggest that murrelets were detected before being significantly disturbed by survey vessels. The effect of errors of this magnitude on murrelet density estimates calculated by DISTANCE, and their implications for use of line transect methodology to survey for murrelets at sea, will be discussed in a sister paper.

MAGELLANIC PENGUINS AT PUNTA TOMBO, ARGENTINA: DO TOURISTS PUSH THEM OVER THE EDGE?

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Over 40,000 tourists visit the Magel-

lanic Penguin (*Spheniscus magellanicus*) colony at Punta Tombo, Argentina every year. The tourists walk directly in the colony, often within inches of nesting birds. To determine if this ecotourism causes elevated stress in penguins, we compared the number of agonistic head movements during 15 minutes of human contact and the level of corticosterone in the blood after 15 minutes of contact between tourist-exposed and naive birds. Tourist-exposed birds had significantly fewer agonistic head movements and significantly lower levels of corticosterone than naive birds, suggesting habituation to human contact. Furthermore, in both naive and tourist-exposed birds, levels of corticosterone after 15 minutes of human contact were far lower than that of penguins subjected to an extreme stress event of capture and one-hour of continuous handling. These results indicate that current ecotourism does not subject Magellanic Penguins to extreme stress. We also compared naive birds with one day of human contact to naive birds exposed to 10 consecutive days of human contact and found a significant decrease in the behavioral response and a decreasing trend in the hormonal response in 10-day birds. This result suggests that newly exposed birds may habituate quickly to human contact and slight increases in ecotourism at Punta Tombo (both in numbers of people or in area of visitation), if well controlled, may not adversely affect nesting Magellanic Penguins. However, continued study of higher levels of human contact (i.e. beyond 15-minutes) are warranted.

CURRENT AND HISTORICAL POPULATION MONITORING: "EASY" MOLECULAR APPROACHES TO COMPLEMENT DIRECT CENSUS AND MONITORING TECHNIQUES, WITH EXAMPLES FROM THE AUKLET'S (*CHARADRIIFORMES: ALCIDAE*)

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Population and productivity monitoring are fundamental components of any research program in organismal biology.

ABSTRACTS

Knowledge of current and historical population dynamics is essential, particularly when species conservation becomes an important issue. Traditional seabird population monitoring projects provide much information on population trends, and many people are involved in the collection of these data, over numerous seasons. Molecular methods, such as DNA sequencing, SSCP (single stranded conformational polymorphism), and microsatellite analyses can be used to complement existing census and monitoring projects. Molecular methods allow the identification of both current and historical population trends, including effective population size and structure at different depths in the evolutionary history of species. Molecular techniques and their corresponding analyses may be accomplished with relative speed and ease, and may be especially useful in the study of populations for which no data exist, or for which data do not span many generations. Assessment of levels of genetic variation can be used to identify vulnerable populations, and to estimate the degree of gene flow or movement of individuals among populations. Often, molecular results confirm what has been observed through statistical trends of population growth and decline, or been suggested by banding studies. We discuss current and historical population sizes of least and crested auklets (*Aethia pusilla*, and *A. cristatella*) as determined by SSCP and direct sequencing analyses. Effective population sizes appear to have been very large for both species (on the order of hundreds of thousands of individuals) over the past several hundred thousand years, if not longer.

GENETIC STRUCTURE AMONG COMMON MURRE POPULATIONS FROM BRITISH COLUMBIA TO CALIFORNIA

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The purpose of this study is two-fold: (1) to help evaluate the relative probability of success of several oil spill-related restoration projects (including natural recovery) for Common Murres in Washington; and (2) to understand both the

overall geographic structure of murre populations in the eastern Pacific, and the evolution of that structure. To these ends, we extracted DNA from murre blood or tissue obtained from birds near Triangle Island (BC), Cape Flattery (WA), Newport (OR), and Gulf of Farallones (CA). We amplified a variety of genetic markers (loci) using polymerase chain reaction (PCR). These loci encompass three classes of genetic markers, each evolving at different rates: nuclear microsatellites, mitochondrial genes (control region and cytochrome b), and a nuclear intron (enolase). We used both population genetic and phylogenetic techniques to test for (1) differences in genetic distances among murre populations; (2) heterozygote deficiencies (i.e., deviations from Hardy-Weinberg); and (3) phylogeographic structure. Preliminary results suggest that Common Murres are geographically structured from British Columbia to California, with all populations showing significant genic differences for at least one locus. However, analyses on the genetic distances among these populations provided ambiguous results, depending on what loci were included. All populations showed heterozygote deficiencies for at least two alleles, but no population showed deficiencies for all alleles, suggesting that deviations from Hardy-Weinberg may be allele-specific and do not represent significant inbreeding.

PARENTAL MASS ACCUMULATION AND MEAL DELIVERY IN FORAGING ADÉLIE PENGUINS IN AREAS WITH DIFFERENT SEA-ICE CONDITION

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To examine how parents regulate own mass maintenance and meal delivery in relation to the distance to foraging area, diving behavior, parental mass change and meal size were measured in chick rearing Adélie penguins in areas with different sea ice condition. Parents made longer trips (40 - 60 hr) at Davis colony

and Dumont d'Urville (DDU) colony (25 - 60 hr) where the sea-ice disappeared in summer than Syowa colony (15 - 25 hr) where the fast sea-ice remained. At each foraging trip, parents accumulated mass faster at Davis (7 g/h) and Syowa 96 (8 g/h) than Syowa 95 (3 g/h) and DDU (-2 g/h). Estimated energy intake per unit time of diving was greater at Syowa 96 (30 KJ/min.) than Syowa 95 (15 KJ/min.), Davis (14 KJ/min.) and DDU (8 KJ/min.). Throughout the chick rearing, average parental mass decrease rate (0.4 - 0.8 g/h) did not differ among colonies but parents brought meals faster at Syowa (2000 KJ/d) than DDU (1800 KJ/d) and Davis (1300 KJ/d). Long foraging trip or greater food intake rate might cause greater mass accumulation but relatively smaller meal delivery possibly because energy accumulation is unlimited while meal size is limited by stomach size. However this trip base variations did not affect parental mass regulation throughout the chick rearing period.

AT-SEA DISTRIBUTION OF XANTUS' MURRELETS IN THE SOUTHERN CALIFORNIA BIGHT, 1995-1997

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In 1995-1997, we captured and radio-marked 153 Xantus' Murrelets at sea beside the largest U.S. breeding colony at Santa Barbara Island (SBI). In 1996-1997, murrelets were patchily distributed in the Southern California Bight (SCB), aggregating in cool upwelling waters mainly near the northern Channel Islands. In 1995, murrelets were less aggregated, mainly in non-upwelling areas during mild El Niño conditions. Average foraging distances from SBI were greater in 1997 (111 ± 44 km) than 1996 (62 ± 25 km). Distances were similar between April and May within years and for "in-

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cubating" versus "non-incubating" murrelets. We attributed low numbers of "incubating" murrelets (repeated visitation to SBI) to capture of many "non-incubating" murrelets (pre-, non-, and failed-breeding adults plus non-breeding subadults),

rather than adverse effects of radio attachment. Changes in foraging patterns between the 1970s and 1990s were associated with potential changes in prey type and distribution in the SCB. Great flexibility in foraging strategies in the SCB is

related to this murrelet's breeding strategy and variable environmental conditions at the south end of the California Current Upwelling System.

POSTER PRESENTATIONS

POTENTIAL NESTING HABITAT OF THE MARBLED MURRELET IN PRINCE WILLIAM SOUND IN RELATION TO FORAGING AREA

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Marbled murrelets (*Brachyramphus marmoratus*) were injured or killed by oil contamination from the Exxon Valdez oil spill of 1989. Maintenance of nesting habitat areas through compatible land management may facilitate population recovery. This study identifies potential nesting habitat of the marbled murrelet in Prince William Sound by linking habitat models to geographic databases of site characteristics. Four scenarios of forested nesting habitat were displayed: 1) large size class, high volume forests; 2) #1 plus increasing contiguous forest patch size; 3) #2 plus distance from shoreline; and 4) #3 plus proximity to known marine foraging areas. Depending on scenario, projections of high nesting potential ranged from 10.7 to 25.2 percent of the 353,290 ha of forest in the study area.

PIGEON GUILLEMOT RESTORATION RESEARCH AT THE ALASKA SEALIFE CENTER

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Pigeon Guillemot (*Cephus columba*) populations in Prince William Sound were affected by the Exxon Valdez Oil Spill and have failed to recover from declines occurring before and after the spill. Three factors have been proposed for the lack of recovery: (1) increased predation on eggs and chicks, (2) reduced prey quality associated with increased dependence on

lower-quality nearshore demersal fish, (3) stress associated with exposure to residual oil.

In 1998 we initiated studies on these three factors. We constructed nesting platforms with nest boxes and decoys at the SeaLife Center in Seward, Alaska and in Prince William Sound to examine the utility of man-made nest cavities in reducing nest predation. We also examined the effect of prey quality on chick growth and fledging by hatching eggs in captivity and raising chicks on four restricted diet treatments ranging from low to high lipid. Growth (body mass) of guillemot chicks fed equivalent biomass diets of different prey was positively correlated with the energy density of those prey. Age at fledging was related to diet treatment. The captive-raised chicks ($n = 24$) were allowed to fledge into the wild from the SeaLife Center and subsequent resightings or recruitment at the nesting platforms could demonstrate the effect of pre-fledging diet on post-fledging survival, and the utility of captive rearing as a direct restoration technique. In 1999-2000, small numbers of chicks will be dosed with oil to allow identification of blood biomarkers of oil ingestion. A lack of prospectors at the nesting platforms and decreased breeding birds at colonies visited for egg procurement in 1998 could indicate Pigeon Guillemot populations are depleted throughout the Gulf of Alaska.

IMMUNE FUNCTION AS A BIOMARKER FOR CONTAMINANT EXPOSURE IN SEABIRDS: DEVELOPMENT OF SAMPLE STORAGE AND ANALYSIS METHODS

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There is need to develop more sensitive and useful biological markers of contami-

nant-induced effects on seabirds. The immune system may be useful in this regard since its complexity renders it sensitive to chronic sub-lethal contaminant exposure. The few studies evaluating contaminant effects on immune function in wildlife show strong evidence for contaminant-induced immunosuppression. Here we evaluate methods for isolation of white blood cells (WBC), cryo-preservation, and assessing function of peripheral WBCs collected from a variety of seabirds. We found double density gradient centrifugation recovered both monocytes and lymphocytes from whole blood collected from Common Murres (*Uria aalge*), Magellanic Penguins (*Spheniscus magellanicus*), Greater Scaup (*Aythya marila*), and Double-crested Cormorants (*Phalacrocorax auritus*). We were successful (>80% viability) with cryo-preservation of WBC from Magellanic Penguins, Greater Scaup and Double-crested Cormorants. In addition, a lymphocyte proliferation assay was evaluated with both fresh and cryo-preserved Greater Scaup and Double-crested Cormorant WBCs. Results to date suggest that this assay will be a sensitive and useful tool for evaluating immune function in seabirds. These newly developed methods will be used in a larger field study of contaminant-induced immunosuppression in wild populations of Double-crested Cormorants. Ultimately, the results of this research may provide a field method that utilizes immune function as a biomarker for secondary effects from sub-lethal chronic contaminant exposure.

CAN BURROW-NESTING SEABIRDS BE IDENTIFIED FROM THEIR BURROW DIMENSIONS?

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To reduce disturbance and increase efficiency, the Alaska Maritime National Wildlife Refuge calculates densities of burrow-nesting seabirds indirectly by counting numbers of small-, medium-, and large-width burrows, with the assumption that birds occupy burrows equivalent to their body size. Burrow width criteria that differentiate species, however, are based on data collected in British Columbia and may not be appropriate for other sites. The objectives of this study were to evaluate and improve this method at Buldir Island, Alaska. During the summers of 1995 and 1996, we measured width and height of 391 burrows, and subsequently verified the species occupying each burrow. We found the current model incorrectly predicted the species in 38% of the burrows. To improve the accuracy of the method, we revised the burrow size criteria based on both mean burrow width and height for each species. The revised size classes were significantly correlated with the expected species and predicted the correct species in 80% of the burrows. We then used the revised size criteria to design a measuring device to distinguish between species at the burrow entrance. The improvement in species prediction from revised size criteria suggests that the measuring device can be used to monitor densities of burrow-nesting seabirds accurately, quickly, and with negligible disturbance at Buldir Island, Alaska.

MOLECULAR EVIDENCE FOR HYBRIDIZATION BETWEEN COMMON AND THICK-BILLED MURRES IN THE NORTH PACIFIC

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The extent of hybridization between common murres (*Uria aalge*) and thick-billed murres (*U. lomvia*) has been the subject of debate. For example, Cairns and De Young's (1981) morphological description of a probable hybrid at a colony in Newfoundland was questioned by Sluys (1983). Using molecular methods, Friesen et al. (1993) discovered a second generation hybrid at a colony in Norway, but this bird was the only hybrid identi-

fied during an extensive survey of genetic variation among common and thick-billed murres breeding in the North Atlantic. In a recent survey of variation in mitochondrial DNA in 120 common murres sampled from the Gulf of Alaska and Aleutian Islands, six (5%) were found to possess DNA sequences characteristic of thick-billed murres. Surveys of variation in nuclear introns and microsatellites revealed that these birds carried various combinations of alleles from common and thick-billed murres, indicating that they represent a mixture of F1, F2 and back-cross hybrids. No hybrids were found in a sample of murres from the western Aleutians. These results have implications both for understanding the evolutionary history of murres and for the conservation of murres in the North Pacific.

TIMING OF NESTLING ABANDONMENT BY TUFTED PUFFIN (*FRATERCULA CIRRHATA*) PARENTS ON TRIANGLE ISLAND, BRITISH COLUMBIA: A PROPOSAL

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The Tufted Puffins (*Fratercula cirrhata*) breeding on Triangle Island, British Columbia have experienced total reproductive failure in 4 of 5 years, between 1994 and 1998. Chick growth rates in the 1990's are low and adults consistently abandon the nestling in mid to late July, before the chick is able leave the burrow and feed independently. What influences the adults' decision to abandon is poorly understood. Life history theory predicts a trade-off between current and future reproduction. Adults should abandon the breeding attempt when the costs of provisioning outweigh the benefits in terms of their lifetime reproductive success. The objective of this study is to investigate the factors that determine when a parent abandons its young. I will study the timing of abandonment in relation to nestling age, mass, growth rate and adult provisioning behaviour. I will conduct intensive focal point observations of breeding pairs to determine provisioning rates, bill load size and composition, and the date when adults abandon. Measurements of nestling mass gain and wing growth will also be taken. I predict positive relationships between the size of the bill loads, frequency of feeding, nestling growth

rate, and the date of abandonment. To experimentally investigate one part of this prediction, I will compare nestling growth rate and timing of parental abandonment in a group of nestlings supplementary fed with Herring (*Clupea harengus*) with an unmanipulated control group.

INLAND MARBLED MURRELET SURVEYS IN THE OLYMPIC EXPERIMENTAL STATE FOREST, WASHINGTON, U.S.A.

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The Washington Department of Natural Resources (DNR) is conducting inland surveys for marbled murrelets (*Brachyramphus marmoratus*) to develop an inventory of murrelet use of state forests. Information from these surveys will be used, along with additional knowledge and hypotheses, to develop region-specific, long-term conservation strategies. DNR began extensive surveys in the Olympic Experimental State Forest (OESF) on the western Olympic Peninsula in 1996. Preliminary analyses of data from a separate study of murrelet habitat relationships allowed us to develop an aerial photography-based model of "clearly good potential habitat" that was specific to the OESF. Using this model, we identified 16,800 ha of generally low to mid-elevation, western hemlock-dominated (*Tsuga heterophylla*) old-growth forest patches variously scattered across the much larger commercial forest landscape. From them, we delineated 427 survey sites (10,983 ha), averaging 26 ha in size, 2-35 km from the ocean. During 1996-98, two-year surveys for occupancy according to the Pacific Seabird Group protocol (1994, 1995) found: 217 occupied (5,911 ha), 182 presence (4,430 ha), and 28 no detection (643 ha) sites. We found occupancy in 92 of 203 (45%) sites near the ocean (2-14 km), compared to 125 of 224 (56%) more distant (14-35 km) sites; and occupancy in 27 of 95 (28%) sites in small habitat patches (<80 ha) compared to 190 of 332 (57%) sites in larger patches. Work is in progress completing surveys in the remaining 5,800 ha of "good habitat".

COASST: DEAD BIRDS, LIVE(LY) FEEDBACK

ABSTRACTS

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COASST, Coastal Observation and Seabird Survey Team, is a volunteer-based beached bird survey program currently under development by the University of Washington and the Olympic Coast National Marine Sanctuary. Drawing from a variety of existing beached bird and other volunteer-based science programs, COASST is designed to track carcass deposition and the factors affecting deposition along the beaches of the outer coast of Washington State. Volunteers are assigned to a knowledge level (1-4), based on the outcome of a post-training field test, where level one is open to everyone and level 4 designates a highly skilled beach-birder. Additional levels (5-6) are reserved for university and museum work. At present COASST is developing along four lines: (1) Creation of a datasheet which combines physical, environmental, and biological data. All data collection is geared towards operational, rather than judgmental, decisions. (2) Creation of a program protocol which will be used during the volunteer training program and as a volunteer "bible" in the field. (3) Creation of a full-color beached bird field guide designed to show seabirds in death rather than life. (4) An outreach program to create a volunteer base. In this poster, we present our draft data sheet, protocol, and a sample page of the field guide. We welcome your feedback!

CHANGES IN DIET OF TERNS AND SKIMMERS NESTING AT THE WESTERN SALT WORKS IN SOUTH SAN DIEGO BAY, CALIFORNIA: APPARENT RESPONSES TO CLIMATE CHANGE AND SHIFTS IN PREY POPULATIONS

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The dikes of the Western Salt Works in south San Diego Bay have been nesting sites of terns for several decades and of Black Skimmer for >20 years. Limited data indicate that Northern Anchovy was the main dietary item for Caspian Terns and Elegant Terns 20-30 years ago, with Pacific Sardine unmentioned as prey. Our

recent studies, based on fish dropped by the birds at the colonies, show changes in diets that appear to be related to ocean warming and shifts in prey populations in California. In 1995, based on dropped fish samples, Pacific Sardine was the most common prey of Caspian Tern and tied with Northern Anchovy for the most abundant prey of Black Skimmer, whereas Northern Anchovy remained the top food item for Elegant Tern. In 1997, based on the same kind of data, Northern Anchovy ranked first and Pacific Sardine second in the diet of Caspian Tern, and Pacific Sardine and California Halfbeak were the two main foods of skimmers. Elegant Terns failed to nest at the site. Pacific Sardine made up nearly 30% of all dropped fish samples and Northern Anchovy only 11%, compared to 10% and 21%, respectively, in 1995. The 1998 data indicates a continuing trend of proportionately more warm-water fish species in the birds' diets.

SEABIRDS AT CASTLE ROCK NATIONAL WILDLIFE REFUGE, CALIFORNIA: POPULATION STATUS, LONG-TERM TRENDS, AND EFFECTS OF THE 1997-98 ENSO EVENT

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Population size of three alcid and three cormorant species breeding at Castle Rock NWR were estimated in 1997 and 1998 as part of a new annual seabird monitoring program. These data were compared with estimates collected at approximately decadal intervals since 1970. The more pelagic foraging species (Common Murre, Tufted Puffin, and Brandt's Cormorant) showed evidence of recent decline, whereas the nearshore foraging species (Pigeon Guillemot, Pelagic and Double-crested Cormorant) did not. Numbers and productivity of all species except the Double-crested Cormorant were depressed in 1998. Common Murres attended the colony throughout the 1998 breeding season, but experienced nearly complete reproductive failure. Tufted Puffin numbers were the lowest on record. The impacts of oceanographic conditions, historic human activities, and ecological changes on the island including intensive use of the refuge by a soaring population of Aleutian Canada Geese, are discussed in relation to long-term seabird population

trends.

DETECTING INTRA- AND INTER-ANNUAL VARIATION IN PREY AVAILABILITY USING DAILY FORAGING TRIP DURATIONS

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The daily energy expenditure (kJ/day) of Black-legged Kittiwake nestlings steadily increases until 23 days of age (Gabrielsen et al. 1992). Response in foraging activities of adult kittiwakes to increasing energetic requirements of their nestlings should differ in three predictable ways depending on prey availability. 1) If prey are easily obtained and the distribution is unchanged throughout nestling development, then negligible effort is required to obtain additional prey and foraging trip duration should remain relatively constant throughout the chick rearing period. 2) If prey are difficult to obtain and availability does not change, then we would predict a steady increase in foraging trip duration and an asymptote when nestlings reach 23 days old. The slope of the curve should reflect the relative difficulty of obtaining prey. 3) If there is within season variation in prey availability, then we should observe an unexpected change in foraging trip duration that is inconsistent with response #1 or #2.

We used data collection computers to monitor daily colony attendance of radio-tagged, adult Black-legged Kittiwakes during three years (1995-97) at three colonies in Prince William Sound, Alaska. Analysis of mean daily trip durations provided examples of the three responses described above. Abrupt or otherwise unexpected changes in trip duration (response #3) typically corresponded with changes in species and/or quantities of prey consumed. Preliminary results indicated that comparing daily foraging trip durations to our three hypothetical responses may provide valuable information about intra- and inter-annual variation in prey availability.

BARREN ISLANDS SEABIRD STUDIES

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ABSTRACTS

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To study the response of seabirds to changes in food availability and quality, we monitored several breeding and foraging parameters of surface-feeding and diving seabirds (Black-legged Kittiwake, Common Murre, and Tufted Puffin) at the Barren Islands, Alaska during the 1995-1998 breeding seasons. Breeding parameters included productivity, nesting chronology, and chick growth rate; foraging parameters were adult nest attendance, foraging trip duration, chick feeding frequency, and chick meal size. We monitored the prey base by examining chick diets and by beach seining; a related study examined adult diets and conducted hydroacoustic and trawl surveys.

During 1998 nesting was late and productivity declined for all three species. Many murre lost first eggs and some relayed. Kittiwakes produced few eggs, and puffin chicks grew slowly. For other parameters, response varied among species. Murre chicks were fed almost exclusively capelin, as in 1995-1997. The proportion of capelin in puffin chick diets increased during 1995-1998.

Although sea-surface temperature near the colony was normal during the 1998 summer, warm water from the 1997 ENSO event reached the area during the preceding late-winter. This signal, apparent both at 250 m in the Gulf of Alaska and near the surface at Seldovia in lower Cook Inlet, coincided with widespread murre mortality. The warm water may have made forage fish less available to seabirds during the pre-breeding season, thereby delaying nesting and reducing breeding success. Our poster compares 1995-1998 results and includes comparisons with previous information from the study site.

THE CHARACTERISTICS OF 23 MARBLED MURRELET NESTS LOCATED BY RADIO TELEMETRY

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During early May, 1998, 40 adult Marbled Murrelets (*Brachyramphus marmoratus*) were captured by dip netting in Desolation Sound, British Columbia, and individually fitted with 1.7g radio transmitters. Of these 40 birds, 24 were tracked

by helicopter to 23 inland nesting locations (both adults had radios at one nest). The nests were found 1.5 to 35 km from the ocean, and were located in the Powell-Daniels drainage, the Bunster Range, E. Redonda Island, and Toba Inlet. One radio was tracked to the nest of a Bald Eagle (*Haliaeetus leucocephalus*). There were 15 birds with radios that were not linked to nest sites. Those birds were either consistently on the water, and breeding, or had an unknown status. The nests were all located within old growth stands, but the stands were highly variable in tree species composition and topography. Nests in the higher altitude Mountain Hemlock biogeoclimatic zone were more successful at rearing chicks than those located in the lower and more highly modified Western Hemlock zone.

TREADING LIGHTLY IN CHANNEL ISLANDS NATIONAL PARK

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Channel Islands National Park and National Marine Sanctuary hosts a unique and diverse spectacle of wildlife. Thousands of breeding seabirds and pinnipeds depend on these isolated islands off the southern California coast. As the population of southern California grows and access to the islands becomes easier, it is vital that we understand how to "tread lightly" on the land and sea. In this video produced by Channel Islands National Park and Spaceport Systems International, we illustrate the beautiful resources of the Channel Islands and techniques you can use to minimize your impact on the wildlife that lives there. Visual images introduce guidelines such as

- pack it in — pack it out
- stay on established trails, and
- maintain a respectful distance from seabirds and pinnipeds both in rookeries and haul outs to numerous visitors traveling to CINP and CNMS every year to experience hiking, kayaking, and diving. The video project provides a tool to educate the public on the susceptibility of seabirds and pinnipeds to human disturbances including presence and pollution.

IMPACT OF THE 1997/98 EL NIÑO ON PELAGIC SEABIRDS IN THE NORTHEAST PACIFIC

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Seabirds may be constrained to reside in specific oceanic regions on the basis of marine characteristics; large-scale events that alter those characteristics should produce changes in seabird community consistent with water-mass alterations. Because the factors that constrain seabirds to particular water-masses are poorly understood, it is difficult to predict their response to changing conditions. In May 1996 I began monitoring seabirds along a repeated 1500km route to Ocean Station Papa. Six surveys were conducted (May, August '96, February, June '97, February, June '98). I expected that the El Niño influenced warming of coastal waters, depression of the thermocline, and northward displacement of the Subarctic Boundary would dramatically alter the seabird community. The results were not entirely as predicted. In support of my predictions, early summer densities (and species number) were lowest in June '97; and species associated with the shelf (Common Murre, Cassin's Auklet, Rhinoceros Auklet) were absent from the June '97 survey. However, confounding observations include: shearwater and Leach's Storm-petrels densities in June '98 surpassed long-term summer averages while densities of most other species remained depressed; and species number (in June '98) returned to pre-El Niño levels, despite the persistence of elevated water temperatures. Preliminary analyses of early summer seabird densities with water parameters (salinity, temperature, nitrate, chlorophyll-a) failed to demonstrate significant correlations. Suggest that water-mass characteristics elsewhere play a major role in shaping local seabird community, and a time lag exists between changing water-mass conditions and response by local seabirds.

ADJUSTMENTS OF THE BODY COMPONENTS TO CONTRASTING ENERGY BUDGETS IN INCUBATING AND CHICK REARING RHINOCEROS AUKLETS

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Seabirds rely on their body fuel reserves

ABSTRACTS

when coming ashore on land for breeding, particularly at the time of incubation. In contrast to this period, the period of chick rearing is a time of very high energy demand. It would expect that they cope with different energy budgets between breeding stages by the adjustments of body components. This study was carried out at Teuri Island in 1996 summer. To examine the body composition and mass of digestive organs, forty Rhinoceros Auklets were sacrificed under the permission from the Minister of Environment. The breeding birds lost their body mass throughout the breeding season. The mass losses were accompanied with loss of lipids and leg muscles. But wet mass of breast muscles and internal organs did not differ between the breeding stages. In nutritional conditions of breast muscles, mass of protein and ash were larger but lipids were smaller for the birds rearing chicks than for those incubating. Water contents did not differ between the breeding stages. These facts suggest that body components of the breeding birds seem to adjust to the different energy budget.

FEEDING AREA OVERLAP AMONG ADELIE PENGUIN COLONIES: A TEST OF POPULATION-REGULATION MODELS

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Furness and Birkhead's (1985) "Hungry Horde Model" proposes that colony size is regulated by competition for food in common foraging grounds within foraging range of one another during the chick provisioning period. Cairn's (1992) "Hinterland Model" predicts that neighboring seabird colonies should occupy non-overlapping foraging areas, and that seabirds should feed closer to their own colony than any other. These models remain largely untested.

Using radio-telemetry in two summers, we defined foraging areas among Adelie Penguins at 4 colonies within one isolated colony cluster in the southern Ross Sea. Longest foraging trips indicated that penguins from each colony were capable of foraging within the range of all the others. Penguins from Capes Bird and Royds on

Ross Island, and those from Beaufort Island — all small to medium-sized colonies — overlapped foraging areas extensively. In contrast, the foraging area of penguins from Cape Crozier, a colony larger than the other three combined, abutted that of the others with no overlap. Crozier penguins supported the Hinterland model, but the others supported the Hungry Horde model. Whether competition was taking place in overlapping areas, in further support of Hungry Horde, is unknown. Intriguing was the fact that Crozier penguins fed right to the western shore of Beaufort Island, with Beaufort penguins feeding, without overlap, immediately off the eastern shore. Were the Beaufort birds avoiding the much more numerous Crozier birds?

HOW SEABIRDS FIND FOOD AT SEA

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How seabirds find food at sea is often not apparent. For example, in the Bering Sea, Least Auklets (*Aethia pusilla*) fly up to 100 km from their breeding colonies to feed on calanoid copepods, which are obtained by underwater pursuit in waters that appear strikingly homogeneous to shipboard observers. Previously we hypothesized that Least Auklets and other seabirds exploit fractal resource landscapes (such as plankton distributions) using a multiscale search strategy, whereby individuals employ area-restricted search tactics to move up local resource density gradients toward fine-scale prey concentrations, but rely on visual observations of other foraging birds as cues to locate potentially more profitable prey concentrations at larger scales. In this study, we tested predictions of the model during cruises around the Aleutian Islands in two years. We found that fine-scale spatial correlations between auklet density and acoustically measured plankton biomass increased with increasing regional auklet abundance and decreased with increasing fractal dimension of the prey distribution (i.e., indicating more complex patterns). We suggest that an ensemble of foraging seabirds behaves as a massively parallel, self-organizing information-processing system. Seabird

colonies may therefore be characterized in part as complex adaptive systems for foraging.

CONSERVATION GENETICS OF BLACK-FOOTED ALBATROSSES: THE ORIGIN OF BYCATCH BIRDS

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Hundreds of thousands of procellariiformes such as Black-footed Albatrosses (*Diomedea nigripes*) are caught every year in longlines spread over the world's oceans. However, for many such species, modeling the demographic impact of longline fisheries is problematic because the precise population sources and population structure of bycatch birds are unknown. To determine the population sources of Black-footed Albatrosses caught in longlines in the North Pacific, we analyzed mitochondrial DNA sequences amplified from tissue samples associated with albatross specimens caught at sea and deposited in the Burke Museum, and compared these to sequences amplified from blood obtained from birds in the two principal breeding areas, Hawaii and Japan. In a 356-bp segment (region I) of the hypervariable control region, we found that the Hawaiian birds ($n = 16$) exhibited almost six times the level of sequence diversity as birds from Torishima Island, Japan ($n = 18$). A phylogenetic analysis indicates that the Japanese birds may have been founded by Hawaiian colonists and that the majority ($n = 9$; 82%) of birds caught in longlines originate from Hawaiian populations, a result consistent with banding data. However, two bycatch birds (18%) possibly originate from Japanese colonies, a rate considerably higher than suggested by banding data. These results suggest that the precision and conclusions of demographic modeling of the impact of longline fisheries on Black-footed Albatross populations can benefit from information on source-sink dynamics gleaned from genetic studies.

SAINT LAZARIA SEABIRDS: DO THEY TELL US ABOUT CHANGES IN THE MARINE ECOSYSTEM IN SOUTHEAST ALASKA?

Leslie Slater. Alaska Maritime National

ABSTRACTS

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Leach's and fork-tailed storm-petrels, glaucous-winged gulls, and common and thick-billed murres and rhinoceros auklets were among the seabird species studied at St. Lazaria Island from 1994-1998. These birds cross a range of feeding guilds (planktivores, opportunists and piscivores, respectively), effectively sampling widely from the marine environment. As food availability changes the health of seabirds, their reproductive health is ultimately affected. Therefore, we monitored several parameters of reproductive output by these seabirds to try to detect changes in the marine environment. Direct sampling of environmental conditions were limited, but nearshore water temperatures were collected to detect within-season changes. Overall productivity of glaucous-winged gulls and murres fluctuated most throughout the study period while productivity in the remaining species changed little. Further results including breeding phenology and food habits are presented in this paper.

EFFECTS OF THE 1997-98 EL NIÑO ON ANCIENT MURRELETS IN HAIDA GWAI

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In 1998, one of the strongest El Niño - Southern Oscillation events in 15 years affected sea conditions throughout the northeast Pacific. To assess the effects of the 1998 El Niño on seabirds in Haida Gwaii (Queen Charlotte Islands), we examined long-term monitoring data relating to Ancient Murrelets in the Laskeek Bay area: East Limestone Island (1990 - present) and Reef Island (1984-89, 1995, 1997). For the first time in ten years of study, half of the breeders deserted their eggs. Breeding success fell by 43 percent from a mean of 1.54 chicks/burrow over 1988-97 to 0.88 chicks/burrow in 1998. Adults weighed at the end of incubation

were found to be lighter than in previous years. Although egg laying was initiated within the usual dates, the spread of chick departures was greater than normal despite fewer chicks produced. However, there was no difference in either egg volume or median chick departures among years. Mean counts of Ancient Murrelets on the gathering grounds were significantly different among years, with 1998 among the highest in nine years. During coastline surveys, we also found the greatest numbers of Marbled Murrelets since 1993, also an El Niño year. We suggest that El Niño induced oceanic conditions caused reduced breeding success in Ancient Murrelets, the effect being more marked than for any event since at least 1988.

MONITORING NORTH AMERICA'S COLONIAL WATERBIRDS: A COMPREHENSIVE PROGRAM

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Long-term conservation planning and management efforts for Colonial Waterbirds (including pelagic seabirds, gulls, terns, and wading birds) require the collection of species location and population trends over a broad geographic range spanning international boundaries. We are leading a cooperative effort to develop a monitoring program for Colonial Waterbirds in Canada, Mexico, the Caribbean, and the United States. The monitoring program consists of (1) a centralized database located at Patuxent Wildlife Research Center (PWRC) and (2) a set of standardized survey methodologies used voluntarily by wildlife managers throughout North America. The database is easy to use and will be designed to allow researchers, resource managers, and volunteers to input and access data via the Internet. Presently, the database consists of data collected by the U.S. Fish and Wildlife Service's Great Lakes and Atlantic Coastal Colonial Waterbird surveys and data from the Cornell Colonial Waterbird Registry. Through a cooperative effort with individual States in the United States, Canadian Provinces, Mexican States, data from past and present surveys will be incorporated, with an attempt to coordinate with Colonial Waterbird

monitoring activities throughout the Caribbean basin. Links to other databases, such as the Pacific Seabird Monitoring database and PWRC's contaminants database, will be developed.

ALASKA/RUSSIA FAR EAST SEABIRD COLONY CATALOG

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The U.S. Fish and Wildlife Service, Anchorage, Alaska in cooperation with the Institute of Biological Problems of the North, Magadan, Russia combined seabird colony data and created the Alaska/Russia Far East Seabird Colony Catalog. The Catalog stores current and historical data on breeding population size, species composition, and location data of 1,705 Alaskan and 453 Russian seabird colonies. Forty-six seabird species are listed and colony sizes range from a few pair to 5.75 million birds. The Catalog consists of a relational database program linked to a geographic information system. The author can provide data reports and detailed maps showing colony locations and sizes for any documented species. The Catalog can also be accessed via the Internet (contact the author for the Internet address). Create maps, download data, and view a video or photograph of a colony or seabird species. Additional web pages are dedicated to learn about seabird species, projects, and personnel. We welcome review of existing data and encourage observers to send new data. Updates are made often and suggestions to improve the Catalog are gladly accepted.

SEABIRD ABUNDANCES OFF SOUTHWEST WASHINGTON, 1972-1998

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Data acquired during July-October on 226 bird-watching trips off Grays Harbor showed changes in numbers of seasonally-resident birds over time, both long-term and also apparently associated with events like the 1976 'Regime Shift', the ENSO event of 1983-1984, and the pro-

longed 'event' of the 1990s. Over the period of 27 years, Black-footed Albatrosses and Northern Fulmars, associated with commercial fishing activity, increased, as did Brown Pelicans and Rhinoceros Auklets. Sooty Shearwaters and four regionally-breeding alcids decreased. Seasonally migrant species — phalaropes, *Stercorarids*, Sabine's Gull and Arctic Tern — were variable, in some cases highly variable, interannually.

RESPONSE OF TUFTED PUFFINS TO INTRODUCED ARCTIC FOX REMOVAL AT NIZKI-ALAIID ISLAND, ALASKA: 1976-1998

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Non-native arctic foxes were introduced to Nizki-Alaid Island in 1911. Foxes prospered by feeding on much of the native avifauna. Burrow nesting species such as tufted puffins were particularly hard hit by foxes. By 1937, those few puffins remaining were restricted to offshore islets inaccessible to foxes. To restore native bird populations, foxes were removed in 1976. Prior to removal, refuge staff counted native birds to document changes after foxes were removed. Since then, staff have visited the island every few years to count. Tufted puffins have responded in the 22 years since fox removal by increasing in abundance and changing their nesting distribution. The approximately 500 individuals observed on the water around the coastline in 1976 had increased to about 3,200 individuals by 1998. Since puffin attendance at the colony is variable, a better indicator of the increase is the number of nesting burrows which increased from about 600 burrows in 1976 to over 12,000 in 1998. Now, nearly all the puffin burrows are on the mainland in areas formerly accessible to foxes. In 1992, 10 index plots of 100m² were established on the mainland and by 1998 the number of burrows in all plots had increased by 60%. In contrast, there are still no nesting puffins on nearby Shemya Island, only 1 mile away, where foxes are still present. The removal of introduced exotic species from island systems as demonstrated at Nizki-Alaid is an effective management action to restore native bird populations.

DIFFERENCES IN TIMING OF INCU-

BATION SHIFTS BETWEEN MALE AND FEMALE THICK-BILLED MURRES ARE ASSOCIATED WITH VARIATION IN MAXIMUM DIVING DEPTHS

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Data on incubation shifts and maximum diving depths of Thick-billed Murres (*Uria lomvia*) at Coats Island, N.W.T. were collected during the 1998 breeding season. The timing and duration of incubation shifts were observed and measured for a group of known individuals over a series of extended observational periods. Results show an average shift length of 12hrs, with females attending mainly at night and males attending during the day. At the same time, data was collected on the maximum diving depths of several individuals at different times of the day. Preliminary results indicate a difference in average maximum diving depths between those individuals that forage during the day and those that forage overnight, with average daytime diving depths greater than those at night. We suggest that timing of incubation shifts may be associated with changes in Thick-billed Murre foraging behaviour.

SOCIAL ATTRACTION TECHNIQUES RESULT IN COMMON MURRE ATTENDANCE AT SAN PEDRO ROCK, A LONG ABANDONED COLONY IN SAN MATEO COUNTY, CALIFORNIA

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San Pedro Rock (SPR) supported at

least hundreds of Common Murres (*Uria aalge*) before extirpation due to eggging and other anthropogenic disturbances in the early 1900's. Breeding by murres on SPR has not been recorded since 1908. As part of the Apex Houston Seabird Restoration Project, we began regularly monitoring seabirds at SPR in 1996 from the adjacent mainland. Murres were not observed during the 1996 and 1997 breeding seasons. After two years of positive results using social attraction techniques at Devil's Slide Rock (DSR), we expanded our restoration efforts to SPR in 1998. A total of 353 life size adult Common Murre decoys and two independent solar powered sound systems were deployed in April. Seven weeks later the first murre was spotted among the decoys. A high count of 26 murres occurred on 16 June. These sightings represent the first documented attendance by murres in over 90 years. We consider attendance soon after social attraction methods were implemented a positive step towards the reestablishment of a Common Murre colony on SPR.

DO DIETS OF COMMON MURRES REFLECT THE COMPOSITION OF LOCAL FISH STOCKS?

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We investigated the diets of common murres *Uria aalge* and their chicks from 1995 - 1997 while sampling fish near three seabird colonies from 1996 - 1997 to evaluate whether these birds diets are good indicators of local fish stocks. Murre diets were composed primarily of fish. We found adult diets to vary significantly from trawl catches in all but two cases (Chisik Island in 1996 and the Barren Islands in 1997). Chick diets varied from trawl catches at all three colonies. Trawl catches in the vicinity of the Barren Islands were least diverse and contained mostly gadids such as walleye pollock *Theragra chalcogramma*. Murres from the Barren Islands ate mostly gadids, but fed their chicks osmerids (capelin *Mallo- tus villosus*). Trawls at Gull Island contained Pacific sand lance *Ammodytes*

ABSTRACTS

hexapterus and gadids. Murres from Gull Island ate almost exclusively sand lance, but a greater proportion of large sand lance than were caught in trawls. Chicks were fed osmerids. Trawls were most

diverse in the vicinity of Chisik Island. Murres from Chisik Island ate a variety of prey, but fed their chicks osmerids. The composition of adult murre stomach samples varied more between colonies

than between years. We conclude that adult murre diets may reflect the composition of local fish stocks, whereas murre chick diets do not.

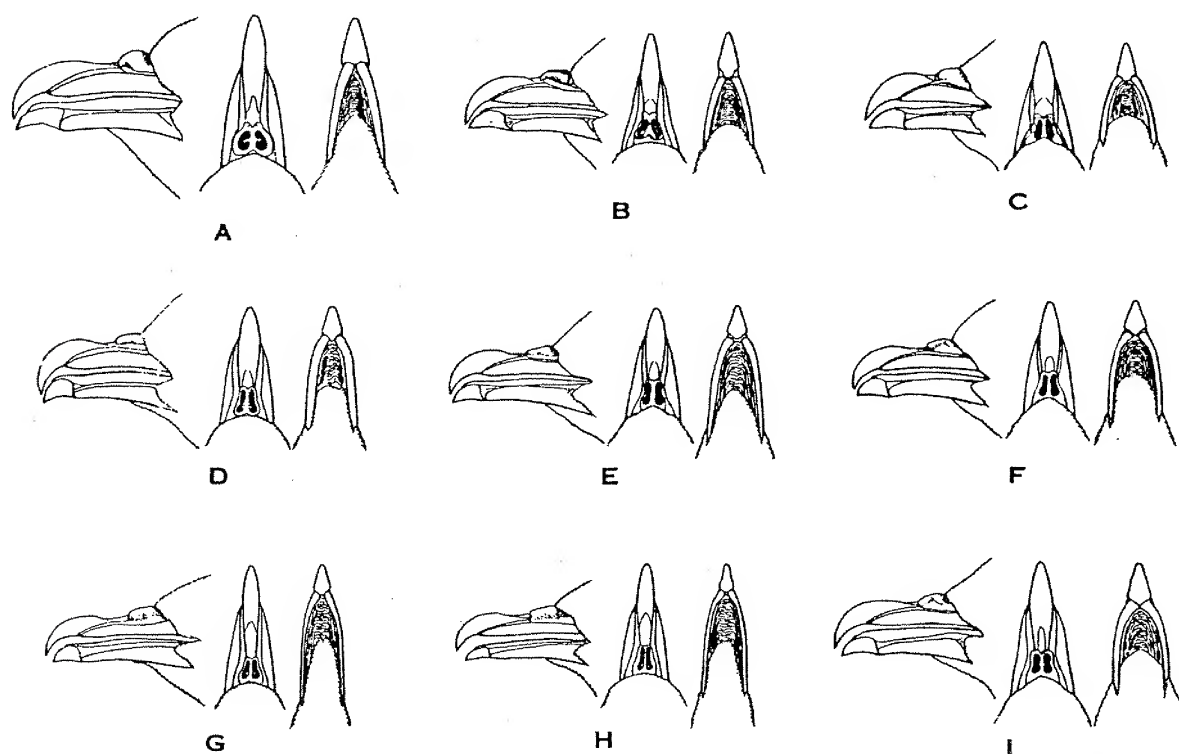


Fig. 3. Bills of nine species and subspecies of Pelecanoididae, drawn from adult specimens; all figures life-size, A, *P. garnoti*; B, *P. magellani*; C, *P. georgicus*; D, *P. urinatrix urinatrix*; E, *P. urinatrix chathamensis*; F, *P. urinatrix berard*; G, *P. urinatrix dacunhae*; H, *P. urinatrix coppingeri*; I, *P. exsul*.

From: Murphy, R.C. and F. Harper. 1921. A review of the diving petrels. Bulletin of the American Museum of Natural History 44(17): 495-554. Page 504.

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